MY WORKING LIFE

The story of a 20th century computer programmer

An Autobiography

by D. J. Pentecost

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and some additional details in June 2023

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To Kai and other members of my family.

To historians of the computer industry.

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Chapter 1: THE SHORTLANDS PRESS

The Shortlands Press former premises (2015 photo), and a Thompson letterpress machine

In some of the school holidays around 1950, I worked in my father's printing shop at 650/652 High Road, Leyton, E10; the business was listed in the local Chamber of Commerce Trade Directory for 1957-58, and for some earlier years too, certainly in 1949, and up to 1974 in Kelly's directories. The business was opened in 1946 with Percy Budd, my father's business partner, whom I think he had met during their service in the Royal Marines during the second world war. My father and I travelled by bus from North Finchley to Leyton, leaving early in the morning. Mostly I worked by collating papers after they came off one of the two printing presses, for example making up sets of 3-part invoices. One of the presses was a Heidelberg, the other a Thompson, which was later moved to my father's printing shop at our North Finchley home. A third machine was a powerful paper cutting and trimming machine, which was hand-driven via a large wheel with a handle to turn it, to lower and raise the cutting blade.

I learned a little about the printing processes, including manual type-setting, picking the pieces of mirror-image type (one per character) from a special typesetter's tray of small boxes, and putting them into a hand-held device, called a composing stick, before transferring a few words into a larger block of pieces of type which would eventually form a single page. You can read more about this process at:

https://letterpresscommons.com/setting-type-by-hand/

GH/BBBG.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

National Physical Laboratory

TEDDINGTON, MIDDLESEX

Please reply to the DIRECTOR *and quote our reference* *Telegrams:* Physics, Teddington *Telephone:* Molesey 1380, Ext. 9

OUR REF: AD(E) 40/9/01B

YOUR REF:

20th November, 1958.

Dear Sir,

I am directed by the Executive Committee of the National Physical Laboratory on behalf of the Council for Scientific and Industrial Research to offer you an appointment as Sandwich Course Student for a period of six months, at a wage of £6.10s.-d. per week. You will work in Mathematics Division.

The appointment will be subject to satisfactory service, and to termination on one month's notice being given in writing on either side at any time.

The maximum allowance of annual leave will be $7\frac{1}{2}$ days in addition to the usual Public Holidays. Sick pay will be allowed in accordance with the regulations from time to time in force.

Your normal hours of attendance at the Laboratory will be 42 per week (Monday to Thursday 9.0 a.m. - 5.30 p.m., Friday 9.0 a.m. - 5.0 p.m., inclusive of one hour each day for lunch.

The following conditions apply to all appointments at the Laboratory:-

(a) No outside professional work may be undertaken without the previous written consent of the Department.

(b) All work done for the Department is confidential and its results must not be disclosed to any unauthorised person.

(c) No member of the staff is allowed to apply for a patent otherwise than as provided for in the approved recommendations of the Report of the Patents Committee of the Civil Service National Whitley Council.

(d) Every member of the staff is under the obligations imposed upon him or her by the provisions of the Official Secrets Acts, 1911 to 1939.

You will also be required to observe the general regulations of the Department as laid down from time to time.

I enclose for your information, a statement on the policy of the Government which limits the range of work on which persons who are members of Communist or Fascist organisations, or, in some cases who have associations therewith, may be employed in Government Departments.

Please confirm in writing your acceptance of employment on the above terms. We understand that you wish to take up your appointment in January, 1959, and perhaps you will indicate the date on which you will be able to commence duty at the Laboratory, please.

Your birth certificate should be forwarded for examination. It will be returned to you in due course.

We shall be pleased to help you find accommodation in this area if you require it.

Yours faithfully,

for Director.

D. J. Pentecost, Esq.,
Torrington Cottage,
Church Path,
Finchley,

My appointment letter to the National Physical Laboratory

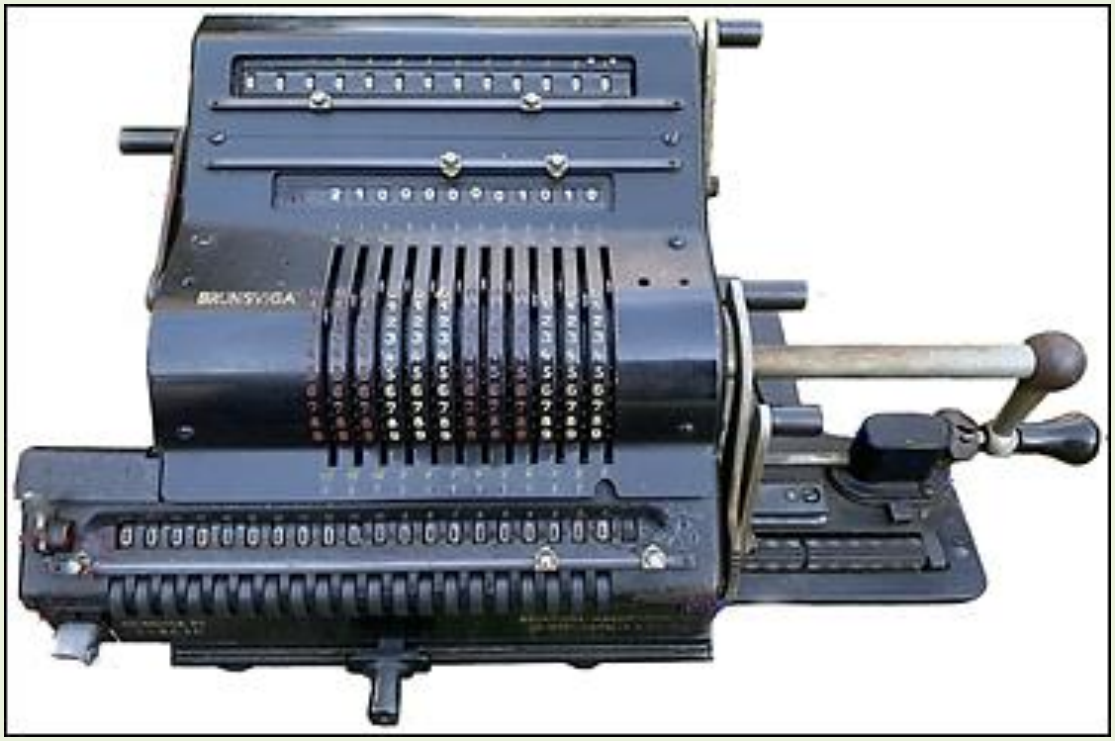
Entrance to the National Physical Laboratory, Hampton Road, Teddington.

For a short period of my life I was technically a Government employee – a member of the Scientific Civil Service. I worked for the Department of Scientific and Industrial Research, (DSIR) from January 1959 for just six months, as a student from Brunel College of Technology, near Acton Town station. It was part of a four year course, providing periods of industrial experience between six month periods of study in mathematics.

I was living with my parents in Finchley, and travelling each day to work in the Mathematics Division of the National Physical Laboratory (NPL) in Teddington. Luckily for me, working there already, was a friend of a primary school friend of mine, and he travelled daily by Lambretta scooter from Whetstone, less than a mile north of Finchley. I met him each morning at Finchley Central Station, and rode pillion from there, on to Teddington, after he had dropped off his girlfriend at the station. His name was Michael Bacon. I think that he worked in the Physics Division of the Laboratory.

My job had a few different aspects. Doing long calculations for the mathematicians was one of them. I used various calculating machines, mostly large electro-mechanical ones, for example a Friden (below left) or Marchant (right).

But I also used a mechanical calculator, and whilst I was still at Brunel, I bought one for home use, a reconditioned large capacity (20 digit) Brunsviga mechanical calculator, from Block & Anderson, made by Grimme, Natalis and Co. A.G., Braunschweig, Germany, between 1931 and 1939. At the time of writing (June 2023), it is in the possession of my grandson Kai Pentecost, for whom I wrote some operating instructions in April 2022: see the Appendix. It is now a museum piece, and is in perfect working order. It could be given to a museum, or auctioned. On 31.10.2016, I found one on eBay on sale for $425+shipping. A photo of my calculator is below; (see the Appendix for operating notes).



Brunsviga 20 large capacity calculator

Other tasks at NPL were working with large scale matrices, multiplying them together for example. The Mathematics Division also had some clever machines for processing punched cards in various ways. They were controlled by plug boards, and I worked on wiring up the boards to control the machines; the process was a bit hit and miss, at least for me!

The most impressive machine was the large Pilot ACE computer, developed from Alan Turing's design for a larger machine called ACE. English-Electric developed the Pilot ACE into a production computer called DEUCE. When I was at NPL, it was the DEUCE computer which programmers were using, and it was in great demand, by many users. Twice a day, there was about half an hour allocated to employees to come and use it for small processing jobs, for which they had already prepared program and data input on 80 column punched cards; this half hour period was called 'popping-in' time; one formed a queue to wait to use the computer for a few minutes.

English-Electric DEUCE at NPL

Somehow, with a struggle, for there was no training course, and I don't even recall seeing a formal manual, I learned to program some aspects of the machine. But I suppose I must have had some individual tuition. Machine code instructions had to be worked out in a quite complicated way, for the computer had no sequence control register, so one had to tell the computer where to find the next instruction after it had obeyed the current instruction. Each instruction needed conversion into binary, and each binary instruction then had to be punched out on an 80 column card: one row per instruction, so twelve instructions per card; see photo below.

I loved that programming – it was huge fun, and I was hooked! I wanted to become a programmer.

A typical hand card punch machine

After my second six months back at Brunel, I felt that I was not going to succeed on the course – I could not follow the electronics teaching at all; nor some of the statistics; the lecturer on the latter subject one day wrote a huge formula across almost the whole length of the large blackboard, and announced that we had to commit it to memory; for me that was impossible. I decided at that moment to quit, but stuck out the course until the end of the six months. I had completed half of the academic part of the course, and one period working in industry. I later learned that of the thirteen students on the course, only one completed it, and he was something of a genius. I joined in the very first year of the course, and I believe that the course level had been pitched too high, because all the students except one, dropped out.

Chapter 3: ELLIOTT BROTHERS (LONDON) LTD (Later, part of Elliott Automation)

Whilst still at Brunel, I bought the Daily Telegraph, around 14th March 1960, and found an advertisement for a junior programmer at a computer manufacturer: Elliott Brothers, in Elstree Way, Borehamwood – luckily not far from home for daily travelling. (This was also not far from my father's father's father's home, which was on the site where now stands Borehamwood's Post office in Borehamwood high street).

I travelled from my Finchley home by motorbike: a Royal Enfield 'Prince' model, with a bright red fairing. Below is a photo of it taken in France, probably somewhere between Beauvais (where my French pen-friend lived), and Le Raincy in Paris (with which Finchley was twinned); the photo may have been taken in Le Raincy, when I was on a 'semi-official' visit to see the Mayor, for at the time, I was secretary and treasurer of the Finchley Council of Youth.

Why that bike? It was because whilst working at the National Physical Laboratory, an employee there travelled to work on a Royal Enfield bike, although larger than the 'Prince' model, and I was so impressed with it, I decided that I wanted one. It was my uncle John Lawrence, home on a visit from his workplace in Kuwait, who arranged to buy it for me at a huge discount though his employer, the Kuwait Oil Company.

Mine was a very impressive looking machine, and the bike was stared at by many people in France, whenever I stopped. They always asked 'How fast does it go?' But it was only 148 cc capacity, with a top speed of 60 mph. Once, I skidded over on black ice when travelling to Elliotts in winter, and I then decided to ride it no more in bad weather. So I sometimes used two buses: one from North Finchley to High Barnet, and then another from Barnet to Elliotts at Borehamwood.

ELLIOTT BROTHERS (LONDON) LTD.

CENTURY WORKS, LEWISHAM, LONDON, S.E.13

TELEPHONE: TIDEWAY 1271 · Established 1800 · GRAMS: OHM LONDON TELEX

BRANCH ESTABLISHMENTS AT ROCHESTER AND BOREHAMWOOD

PER/GER/EH.

31st March, 1960.

Mr, D. J. Pentecost,
Torrington Cottage,
Church Path,
Lodge Lane,
Finchley. N. 12.

Dear Mr. Pentecost,

We have pleasure in offering you the post of Junior Programmer in our Organisation and Methods Department, at a salary of £550/-/- per annum, and in accordance with the enclosed Conditions of Service. You would be based at our Head Office, and operate at our Borehamwood Establishment.

We shall be glad to learn as soon as possible as to whether or not you accept our offer, and if so the earliest date upon which you would be available to take up your duties with us.

Yours faithfully,
For ELLIOTT BROTHERS (LONDON) LIMITED.

G. E. Robson,
Personnel Manager.

Encl.

The old 2-storey Elliott building is in the foreground on the right. The large L-shaped building in the background was the newest Elliott block. My office was on the third floor of the wing on the left side of the photo. I also spent many hours in the computer bureau/showroom which you can see fully illuminated on the ground floor on the left side of the photo. All these buildings were later demolished for redevelopment.

Here is part of the computer showroom/service bureau,
showing an Elliott 4130 (foreground) and an Elliott 4120 (background).
These models were respectively introduced in 1965 and 1967, after I had left Elliotts.

I applied for the post, and after interview on 29th March 1960 by a couple of high level programmers and computer designers, I was accepted, to start on 19th April 1960, in the Internal Computer Applications (ICA) department of Elliotts, working on the third floor, above the vast and impressive ground floor computer showroom/service bureau, which was said to be the biggest in the world at the time. I spent many hours in that computer room, sometimes working through the night on the Elliott 405 computer.

An Elliott 405 computer; I think this one was at NCR's premises in London

There appear to be no photographs taken of the Elliott computer bureau room in the early 1960s, showing the two 405s, the 402 and the film and lineprinter output machines. The above photo is the best I could find showing a good portion of a 405.

But I was keen to find a better photo of the console of the 405, including a paper tape punch and reader, and Google helped me after a long search to track one down**.** Below is one of the best photographs which I have come across. I found it in March 2017 as a small image on the website of the Powerhouse Museum in Sydney, Australia, which is part of the Museum of Applied Arts & Sciences.

The tiny black and white photo is at https://collection.maas.museum/object/210779.

I clicked on the photograph and was delighted to find a much larger high quality image, but the original print had been degraded over the decades by creases, scratches, and hundreds of the black and white patches which are commonly found on old photographs; the images of the people's faces had been damaged by white marks.

I spent several hours restoring the worst of the damage, and the result you can see below.

Copyright is thought be owned by National Cash Register Co. Ltd

In 2011, I had corresponded with Matthew Connell at the Powerhouse Museum about my involvement in the development of the British computers heritage website (see Chapter 11). I sent him a copy of the improved photo, asking for the identity of the computer installation, and for caption details which I should use to include the photo in this book. He was delighted with the restored photo, and told me that the computer was installed at the commercial computer bureau office of the National Cash Register Co. Ltd, in 1959 at Barrack Street, Sydney, the first bureau of its kind in Australia. Most 405 photos show the whole of the installation; this one for a change, concentrates on the console and the electro-mechanical input and output devices.

Shortly after my arrival and induction at Elliotts, I was sent on an excellent two or three week 405 computer programming course run by The National Cash Register Company (NCR) in Marylebone Road, London. Elliotts had an agreement with that company for them to market the 405 computers and run training courses. I was scheduled to work on writing programs for the 405, probably physically the largest commercial machine ever made by Elliotts.

Although I was at Elliotts for only a short time (April 1960 to September 1962), that period proved to be one of the most useful for my future career, and oddly, later in retirement. It enabled me to contribute 45 years later, and after a considerable amount of research conducted over several years, to writing a significant amount of an Elliott section of the history of British computers website, which is published at www.ourcomputerheritage.org,

and which has been formally adopted for archiving by the British Library. More on this subject appears in Chapter 11.

My time at Elliotts was spent mostly on writing 405 programs for the stock control system required by Elliotts to assist in its manufacturing processes. But I was also required to write a few library programs for the 405, not only to help Elliotts themselves, but also to make them available to Elliotts' 405 customers, one or two of whom I visited.

******

One library program which I wrote, was to enable the time taken by another program, or a critical part of another program, to be measured precisely; if it was found to be working too slowly and was causing a job to take much too long to run on the computer, then steps might be taken for a full or partial re-write of the program, to improve its efficiency. This was important, because some processes on computers designed in the 1950s took many hours to complete, and available time on a computer was often at a premium. In addition, computers were not as reliable as they are today, and a job which should take several hours to run, might not finish, because of a computer hardware failure. An engineer was usually on stand-by in case of such failure.

Another library program's function was to sort data. A new sorting technique, known internationally now as Quicksort, (see Wikipedia for a brief explanation) had been invented by Tony Hoare (see also Wikipedia), another Elliott employee, who was in 2016 Emeritus Professor at Oxford University.

My boss, the head of the ICA department, Patrick Shackleton, had written the old existing sort program used by most Elliott customers. He was surprised at the claimed better efficiency for Quicksort, and was determined to prove whether or not it would be faster that his own program, when run on the 405 computer. So he designed and wrote Quicksort for the 405, but was unable to get it to work at all. In frustration, he gave the coding sheets to me, with instructions to find the errors and make it work.

As far as I knew, he had written the program without having specified it in logical steps on paper, and without having drawn a detailed logic flowchart. So I set about reading the coding sheets, and at the same time drawing a flowchart from the code, in order to try to understand the complex logic. After many days of studying the coding sheets, I finally had a flowchart completed.

So I then set about trying to understand it, to find out what the program was supposed to do. It was I think the toughest intellectual task I have ever undertaken, for the logic of the flowchart did not make sense. Finally I found two places where a jump instruction at the end of a loop was returning back to an illogical point in the coding; I made corrections. I then began to understand what the correct sorting process was intended to be. Having found the innermost loop in the process, which needed to work at maximum efficiency, I re-wrote it, so that it executed faster.

Then I tested the program several times on small and large sets of data held on the 405's disc. Quicksort finally worked on the 405 for the first time, and it was also the first time

Quicksort had been used on a computer where the data was stored on a sectored disc. But was it faster than Shackleton's old sort program? I used my timing program to measure both sort programs, each operating on the same sets of data. Quicksort was indeed faster, and it now forms the basis of nearly all computer sort programs, worldwide. Tony Hoare published his Quicksort paper in the British Computer Society's Journal (Vol. 5, no. 1, 1962, pp. 10-15); his article mentions me as having run timing tests for Quicksort.

******

From time to time, internal courses were held at Elliotts, designed to teach some aspects of computing to new employees. My section of one of the courses was to explain the timing of part of the 405 computer's instruction set, known as 0-code orders. I gave the lecture on 28th February 1962 in the Borehamwood office of Elliotts.

The contents of the talk are formally set out in part of the Computer Conservation Society's website at ourcomputerheritage.org, and specifically on pages 180-183 at https://ourcomputerheritage.org/Maincomp/Eli/E2ExtraManuals.pdf (at the time of writing). I was responsible for researching and producing the whole of that 186 page section of the website, between 2003 and 2011.

******

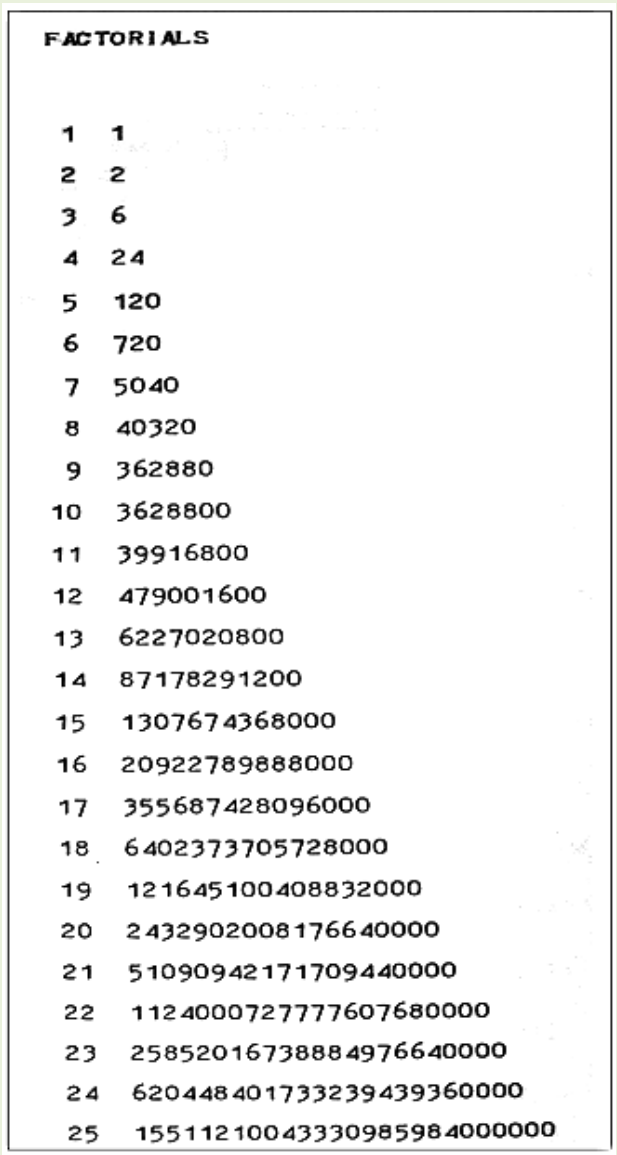
I sometimes spent very long hours at Elliotts' Borehamwood offices, occasionally through the night, when it was quiet, with no interruptions to concentration. One day I fainted after stepping out of the lift on the third floor. I was taken to the medical room in Elliotts' small old building to recover, where it was suggested that I had not been eating enough. The diagnosis was correct. But I was not the only one who often worked through the night. My colleague and life-long friend Harry Lawrence also liked to do this. Sometimes we would go out in his car very late at night or in the early hours to a lorry drivers' café which never closed; it was called the Busy Bee, and I think it was somewhere on the A41 road.

We had to complete time-sheets in those days, which were not designed for working outside normal hours. There were sometimes weeks on end when Harry recorded apparently very few hours or no hours worked at all, because night hours were not recordable on the sheets. He delighted in scrawling over the whole week's time-sheet just two words: ODD TOIL, which puzzled the administration staff, and he was summoned to explain himself. He said that the abbreviation stood for 'Out During the Day – Time Off In Lieu', because he had been working at night. This amused me, so I did the same, although I was rarely absent for the whole of a day's working hours, so I always had some hours recorded, as well as some ODD TOIL entries.

******

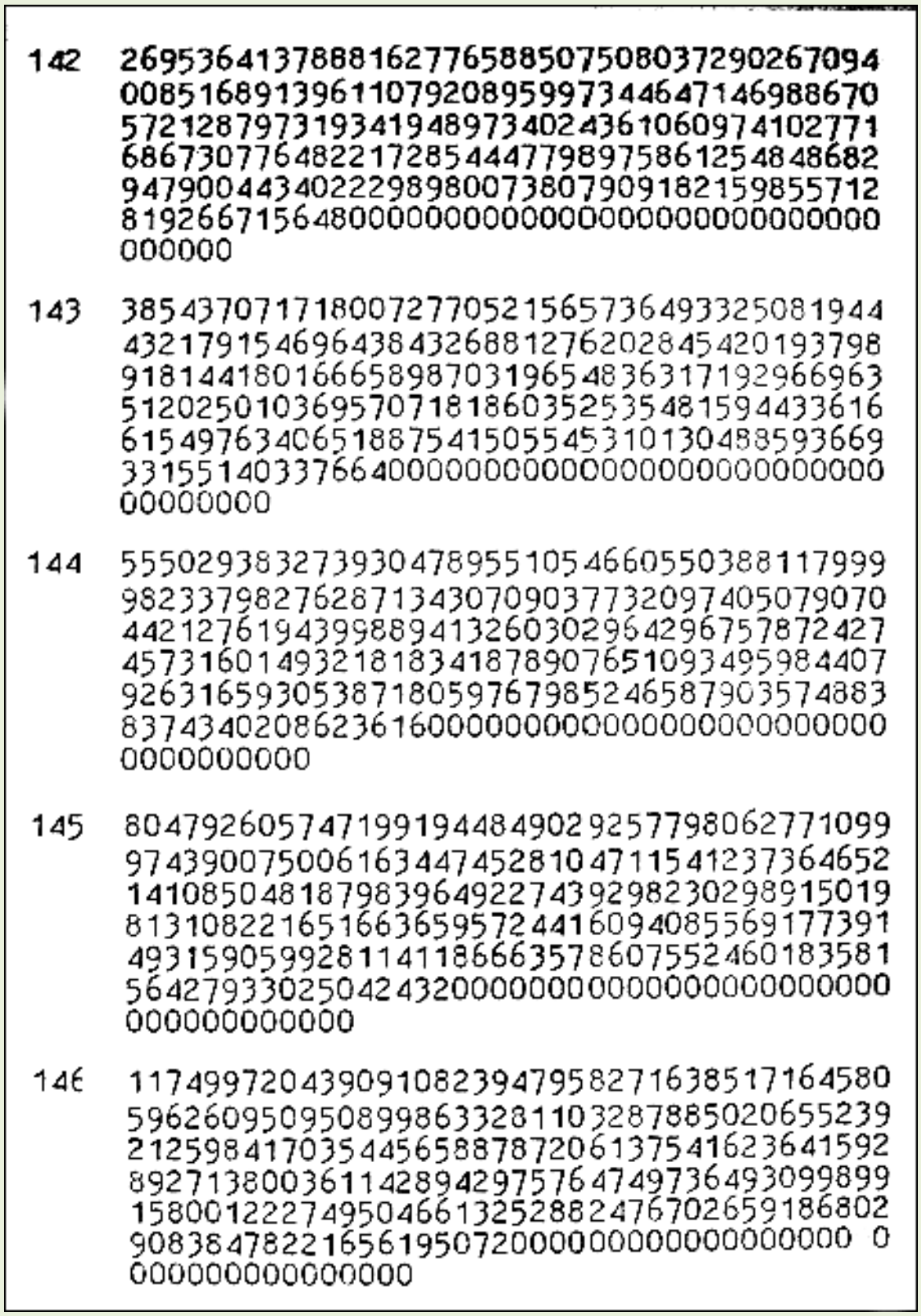
I spent some of my time whilst at Elliotts, after normal working hours, writing some programs for fun. One of them was to calculate and print a list of factorials – as many as the computer reasonably could, without involving an enormous programming effort.

I still have the complete results listing, but I am showing here just the first and last pages. The program stopped at factorial 146, which has 255 digits, so there was clearly a storage limitation which caused the program to stop. The results had to be stored on the computer's hard disc, because the computer's fast memory was not large enough, and was microscopically small by today's standards. The challenge of the programming, was to work out a method of calculating numbers of enormous length, and being able to print them in a readable decimal form.



FACTORIALS

1 1
2 2
3 6
4 24
5 120
6 720
7 5040
8 40320
9 362880
10 3628800
11 39916800
12 479001600
13 6227020800
14 87178291200
15 1307674368000
16 20922789888000
17 355687428096000
18 6402373705728000
19 121645100408832000
20 2432902008176640000
21 51090942171709440000
22 1124000727777607680000
23 25852016738884976640000
24 620448401733239439360000
25 15511210043330985984000000



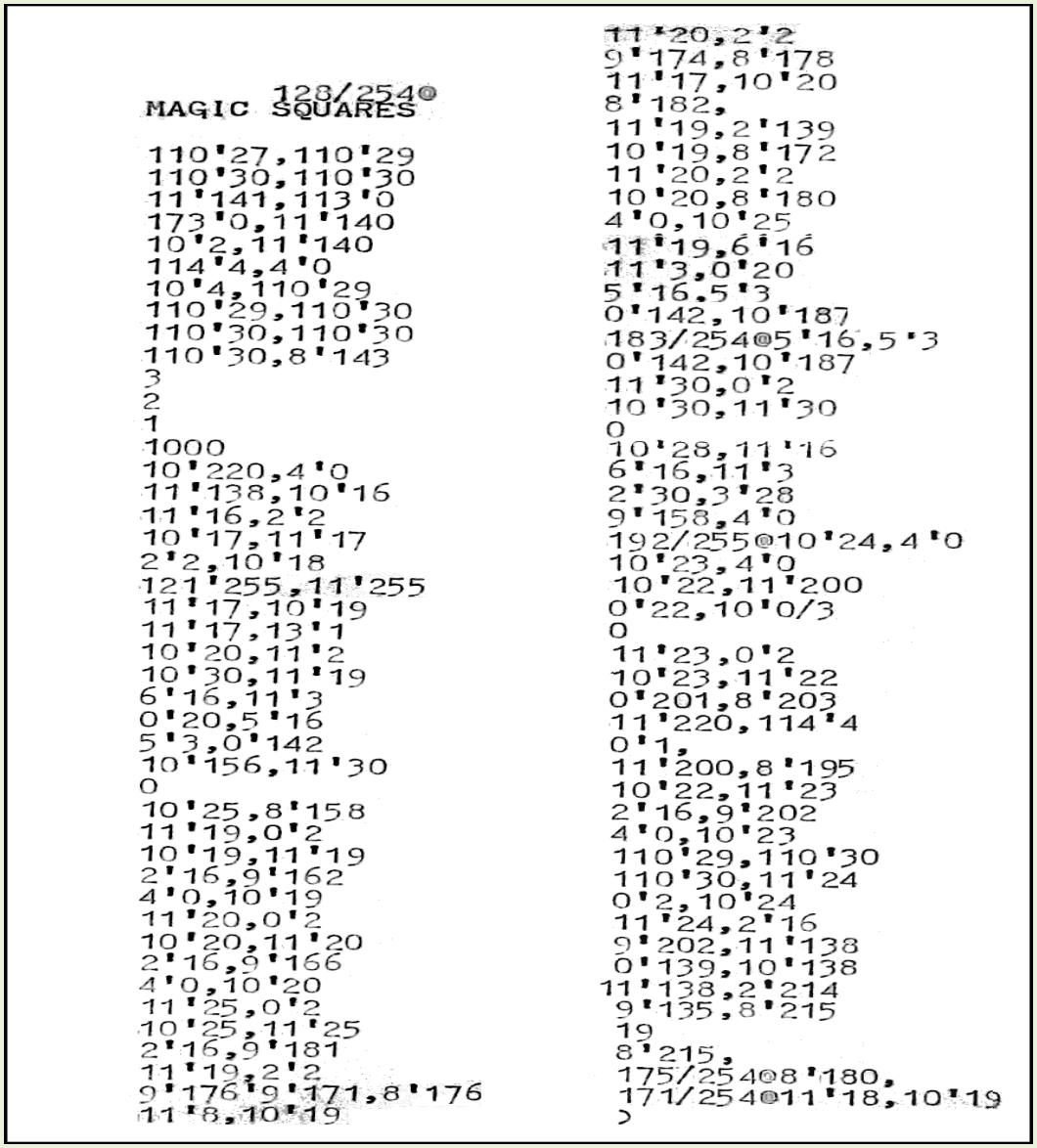
Last page of a list of factorials calculated on the Elliott 405 computer

How long would it take to program a modern computer to perform the same task? It ought to be much quicker, but I wonder. Would there be capacity problems? Certainly it would be far quicker to execute the program. Unfortunately I did not keep the 405 program coding sheets.

Another program which I wrote for fun, was to calculate and print out some magic squares. A magic square is a square grid of numbers, in which the numbers in every row and every column add up to the same total. And the numbers in the two diagonals also add up to that same total. Here is a very simple example, where all the totals are 15:

4 9 2
3 5 7
8 1 6

Below is the paper tape program listing, and on the next page the set of results. The magic squares are shown in two columns, reduced for ease of display, to smaller than their original size; on the actual printout they were printed on a single piece of continuous stationery. The last magic square completely filled the width of the paper.



```
                128/254@
MAGIC SQUARES

110'27,110'29
110'30,110'30
11'141,113'0
173'0,11'140
10'2,11'140
114'4,4'0
10'4,110'29
110'29,110'30
110'30,110'30
110'30,8'143
3
2
1
1000
10'220,4'0
11'138,10'16
11'16,2'2
10'17,11'17
2'2,10'18
121'255,11'255
11'17,10'19
11'17,13'1
10'20,11'2
10'30,11'19
6'16,11'3
0'20,5'16
5'3,0'142
10'156,11'30
0
10'25,8'158
11'19,0'2
10'19,11'19
2'16,9'162
4'0,10'19
11'20,0'2
10'20,11'20
2'16,9'166
4'0,10'20
11'25,0'2
10'25,11'25
2'16,9'181
11'19,2'2
9'176,9'171,8'176
11'8,10'19
11'20,2'2
9'174,8'178
11'17,10'20
8'182,
11'19,2'139
10'19,8'172
11'20,2'2
10'20,8'180
4'0,10'25
11'19,6'16
11'3,0'20
5'16,5'3
0'142,10'187
183/254@5'16,5'3
0'142,10'187
11'30,0'2
10'30,11'30
0
10'28,11'16
6'16,11'3
2'30,3'28
9'158,4'0
192/255@10'24,4'0
10'23,4'0
10'22,11'200
0'22,10'0/3
0
11'23,0'2
10'23,11'22
0'201,8'203
11'220,114'4
0'1,
11'200,8'195
10'22,11'23
2'16,9'202
4'0,10'23
110'29,110'30
110'30,11'24
0'2,10'24
11'24,2'16
9'202,11'138
0'139,10'138
11'138,2'214
9'135,8'215
19
8'215,
175/254@8'180,
171/254@11'18,10'19
>
```

It looks to me as though there is an error in the penultimate line in the first column, which must have been corrected before the program was run, but not corrected on the paper tape. Or perhaps the paper tape which I kept was not the final working version. So here is a puzzle for a keen future student to solve, by referencing the 405 computer instruction set described in the website at www.ourcomputerheritage.org

```
MAGIC SQUARES

  1

  4  9  2
  3  5  7
  8  1  6

 11 18 25  2  9
 10 12 19 21  3
  4  6 13 20 22
 23  5  7 14 16
 17 24  1  8 15

 22 31 40 49  2 11 20
 21 23 32 41 43  3 12
 13 15 24 33 42 44  4
  5 14 16 25 34 36 45
 46  6  8 17 26 35 37
 38 47  7  9 18 27 29
 30 39 48  1 10 19 28

 37 48 59 70 81  2 13 24 35
 36 38 49 60 71 73  3 14 25
 26 28 39 50 61 72 74  4 15
 16 27 29 40 51 62 64 75  5
  6 17 19 30 41 52 63 65 76
 77  7 18 20 31 42 53 55 66
 67 78  8 10 21 32 43 54 56
 57 68 79  9 11 22 33 44 46
 47 58 69 80  1 12 23 34 45

 56 69 82 95 108 121  2 15 28 41 54
 55 57 70 83 96 109 111  3 16 29 42
 43 45 58 71 84 97 110 112  4 17 30
 31 44 46 59 72 85 98 100 113  5 18
 19 32 34 47 60 73 86 99 101 114  6
  7 20 33 35 48 61 74 87 89 102 115
116  8 21 23 36 49 62 75 88 90 103
104 117  9 22 24 37 50 63 76 78 91
 92 105 118 10 12 25 38 51 64 77 79
 80 93 106 119 11 13 26 39 52 65 67
 68 81 94 107 120  1 14 27 40 53 66

 79  94 109 124 139 154 169   2  17  32  47  62  77
 78  80  95 110 125 140 155 157   3  18  33  48  63
 64  66  81  96 111 126 141 156 158   4  19  34  49
 50  65  67  82  97 112 127 142 144 159   5  20  35
 36  51  53  68  83  98 113 128 143 145 160   6  21
 22  37  52  54  69  84  99 114 129 131 146 161   7
  8  23  38  40  55  70  85 100 115 130 132 147 162
163   9  24  39  41  56  71  86 101 116 118 133 148
149 164  10  25  27  42  57  72  87 102 117 119 134
135 150 165  11  26  28  43  58  73  88 103 105 120
121 136 151 166  12  14  29  44  59  74  89 104 106
107 122 137 152 167  13  15  30  45  60  75  90  92
 93 108 123 138 153 168   1  16  31  46  61  76  91

106 123 140 157 174 191 208 225   2  19  36  53  70  87 104
105 107 124 141 158 175 192 209 211   3  20  37  54  71  88
 89  91 108 125 142 159 176 193 210 212   4  21  38  55  72
 73  90  92 109 126 143 160 177 194 196 213   5  22  39  56
 57  74  76  93 110 127 144 161 178 195 197 214   6  23  40
 41  58  75  77  94 111 128 145 162 179 181 198 215   7  24
 25  42  59  61  78  95 112 129 146 163 180 182 199 216   8
  9  26  43  60  62  79  96 113 130 147 164 166 183 200 217
218  10  27  44  46  63  80  97 114 131 148 165 167 184 201
202 219  11  28  45  47  64  81  98 115 132 149 151 168 185
186 203 220  12  29  31  48  65  82  99 116 133 150 152 169
170 187 204 221  13  30  32  49  66  83 100 117 134 136 153
154 171 188 205 222  14  16  33  50  67  84 101 118 135 137
138 155 172 189 206 223  15  17  34  51  68  85 102 119 121
122 139 156 173 190 207 224   1  18  35  52  69  86 103 120

137 156 175 194 213 232 251 270 289   2  21  40  59  78  97 116 135
136 138 157 176 195 214 233 252 271 273   3  22  41  60  79  98 117
118 120 139 158 177 196 215 234 253 272 274   4  23  42  61  80  99
100 119 121 140 159 178 197 216 235 254 256 275   5  24  43  62  81
 82 101 103 122 141 160 179 198 217 236 255 257 276   6  25  44  63
 64  83 102 104 123 142 161 180 199 218 237 239 258 277   7  26  45
 46  65  84  86 105 124 143 162 181 200 219 238 240 259 278   8  27
 28  47  66  85  87 106 125 144 163 182 201 220 222 241 260 279   9
 10  29  48  67  69  88 107 126 145 164 183 202 221 223 242 261 280
281  11  30  49  68  70  89 108 127 146 165 184 203 205 224 243 262
263 282  12  31  50  52  71  90 109 128 147 166 185 204 206 225 244
245 264 283  13  32  51  53  72  91 110 129 148 167 186 188 207 226
227 246 265 284  14  33  35  54  73  92 111 130 149 168 187 189 208
209 228 247 266 285  15  34  36  55  74  93 112 131 150 169 171 190
191 210 229 248 267 286  16  18  37  56  75  94 113 132 151 170 172
173 192 211 230 249 268 287  17  19  38  57  76  95 114 133 152 154
155 174 193 212 231 250 269 288   1  20  39  58  77  96 115 134 153
```

Results of the Magic Squares 405 computer program

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Whilst at Elliotts, my boss, Patrick Shackleton, advised that I should join the British Computer Society (BCS), which I did, being allocated the membership number 2954. I attended a few of the specialist BCS group meetings. In the 1980s when I was working at Coward Chance (see Chapter 9), I enquired about applying for a Fellowship of the BCS, in relation to the major project which I had then managed, but I was unable to apply because I was out of time according to the Fellowship application rules. Much later, in April 2001, I bought life membership of the BCS for £395, and in May 2004 I was elected as a Chartered Member of the BCS:

Membership No. 00029540

BCS

This is to certify that

David John Pentecost

was elected a Chartered Member

of

The British Computer Society

on the 1st day of May 2004

by the resolution of the Council

THE BRITISH COMPUTER SOCIETY

Chairman of Council

Chief Executive

The holder of this certificate has undertaken to observe and abide by the Professional Code of Conduct

******

Fellowship of BCS

I shall now take a diversion from describing my employment at Elliott's, to relate a short version of the saga which ensued decades later, about BCS Fellowship. In 2022, (I think in May), I received an email from BCS, announcing a new method of applying for Fellowship, and I decided to apply, having asked two referees who knew about my work, one of whom was already a Fellow, to act as supporters for me. They agreed, and I submitted my application in July, after a great deal of technical difficulty with the BCS website, and many email exchanges. I was given the impression that I was the only Life Member who had ever applied to become a Fellow, and the BCS membership computer system was not programmed to deal with this situation, nor to accept my Fellowship payment. In the end, BCS agreed to take my payment by credit card by telephone.

In October 2022, I received another email from BCS, saying that the assessors wanted more details about certain aspects of my career. I was by then feeling rather fed up with the Fellowship application process, and illness hit me for a while, preventing further action by me. BCS reminded me in December, that they were still waiting for further details, and I sent off my reply to them a few days later. Early in January 2023, BCS told me that my additional details had been passed to their assessors. Early in March 2023, I emailed BCS, asking if they could tell me when a decision would be made about my Fellowship application. I received a reply the following day, telling me that I had been successful, but that the BCS membership computer system was not yet able to handle the change of my status, and I could not yet be shown on the BCS website in the public list of Fellows.

I had heard nothing by 11th April 2023, so I emailed the BCS again, asking for the email address of the Director of Membership & Registrations, so that I could make a formal complaint about the extraordinary delays and mistakes. I was given his email address the next day, and was also told that the computer system had been fixed, and that my Fellowship would be on the BCS computer system by the end of that day. More errors followed, and incorrect certificates were sent to me over the next few weeks. On 17th May 2023, I was finally sent an emailed certificate which I was told had been specially prepared for me confirming my Fellowship. I was disappointed, because it was not the kind of certificate which I expected from a leading learned society, and not one which I would be very proud to have framed and displayed in my office or home. I show it below. I had some new business cards printed as a result of needing to change MBCS to FBCS; see below.

bcs
The Chartered Institute for IT

Certificate of BCS Membership

This is to certify that

David John Pentecost CITP FBCS

Was awarded

Grade: Chartered Fellow

On the 12th day of April 2023

Membership number: 29540

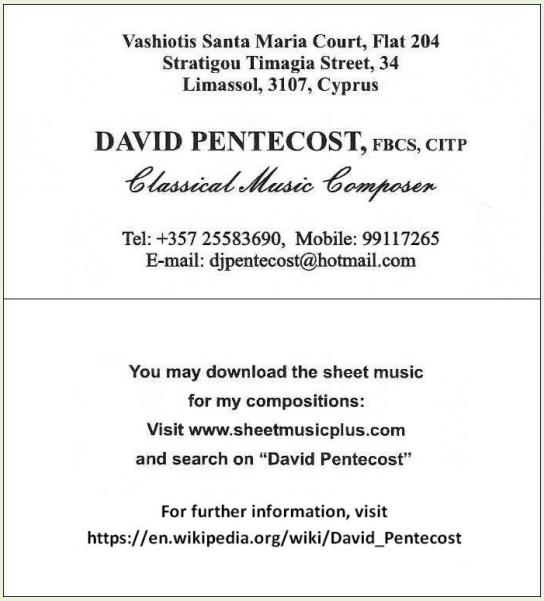
Life Member

R. Parmar

Rashik Parmar MBE FBCS
Group CEO

Gillian Arnold

Gillian Arnold FBCS
President



Vashiotis Santa Maria Court, Flat 204
Stratigou Timagia Street, 34
Limassol, 3107, Cyprus

DAVID PENTECOST, FBCS, CITP

Classical Music Composer

Tel: +357 25583690, Mobile: 99117265
E-mail: djpentecost@hotmail.com

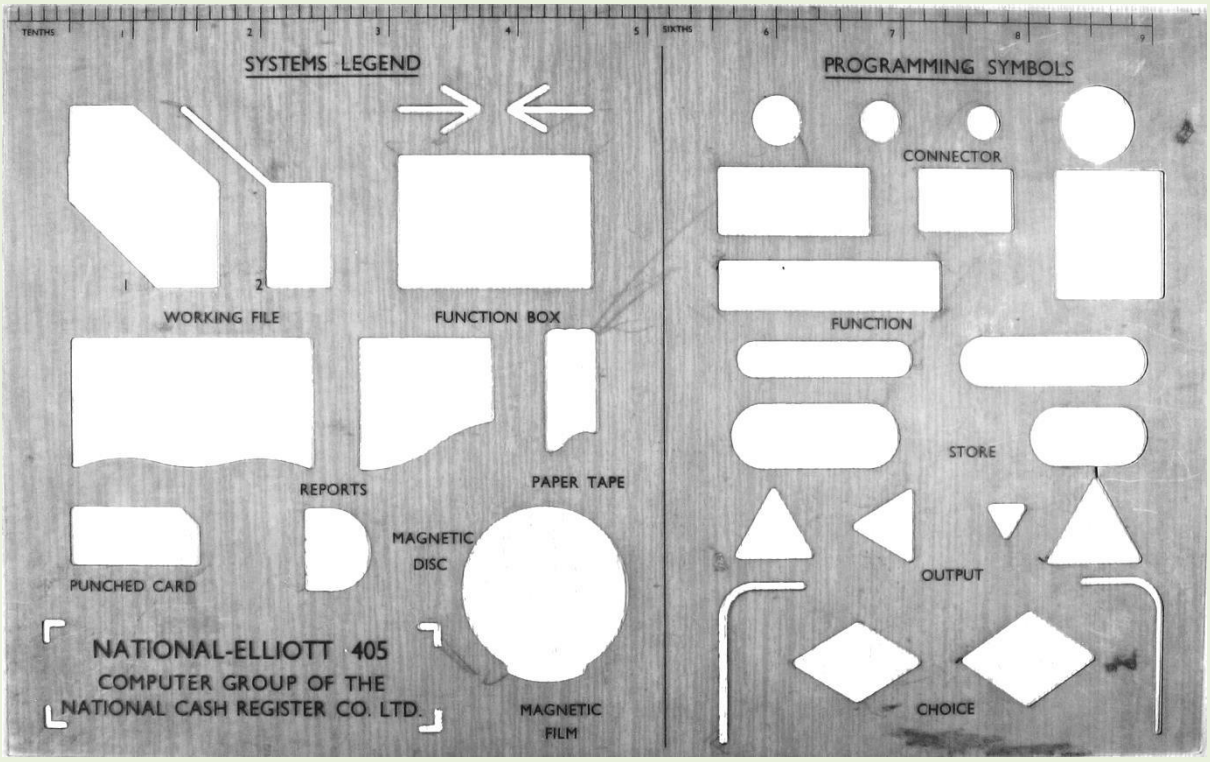
You may download the sheet music
for my compositions:
Visit www.sheetmusicplus.com
and search on "David Pentecost"

For further information, visit
https://en.wikipedia.org/wiki/David_Pentecost

Now, back to my work at Elliott's, and I shall describe some of the practical aspects of my employment there, to explain that developing computer programs had many physical aspects to it – I wasn't just sitting at a desk writing lines of code on a programming sheet.

How did we prepare a computer program at Elliotts? The first stage was to define the function of the program. This could be a very short process, as in the case of my 'fun' programs mentioned above, or for a commercial application, it could take weeks of investigation and discussion with the users of the eventual system. Such a system could require the specification of more than one program for a complete system.

But what about a single program? The first step was to draw a flowchart to enable the writing of the code to be undertaken more reliably than without such a logic chart; typically this would be a freehand drawing. The drawing might be produced very neatly at the end of a project, if required to form part of the formal project documentation.



The flowcharting template which I used

The programming symbols on the template were not entirely adequate. In particular, it was often impossible, because of lack of space, to express a clear question inside the tiny CHOICE diamond shapes, and I resorted to using the STORE symbols, sometimes much larger than on the template, for defining decisions.

The program code would be written on a set of blank program sheets, following the flowchart. Below is an example of half of one such completed program sheet.

NATIONAL-ELLIOTT 405 PROGRAM

SHEET 1 OF 2

TITLE AUTOMATIC TIMING ROUTINE

LIBRARY ROUTINE 405 PT 02/DJP

PROGRAMMER D.J. PENTECOST.

DATE MAY 1961

COST CODE 310/833

DIRECTORY 192/400; @ cr if bl

BLOCK

LABEL * cr if bl

SECTOR

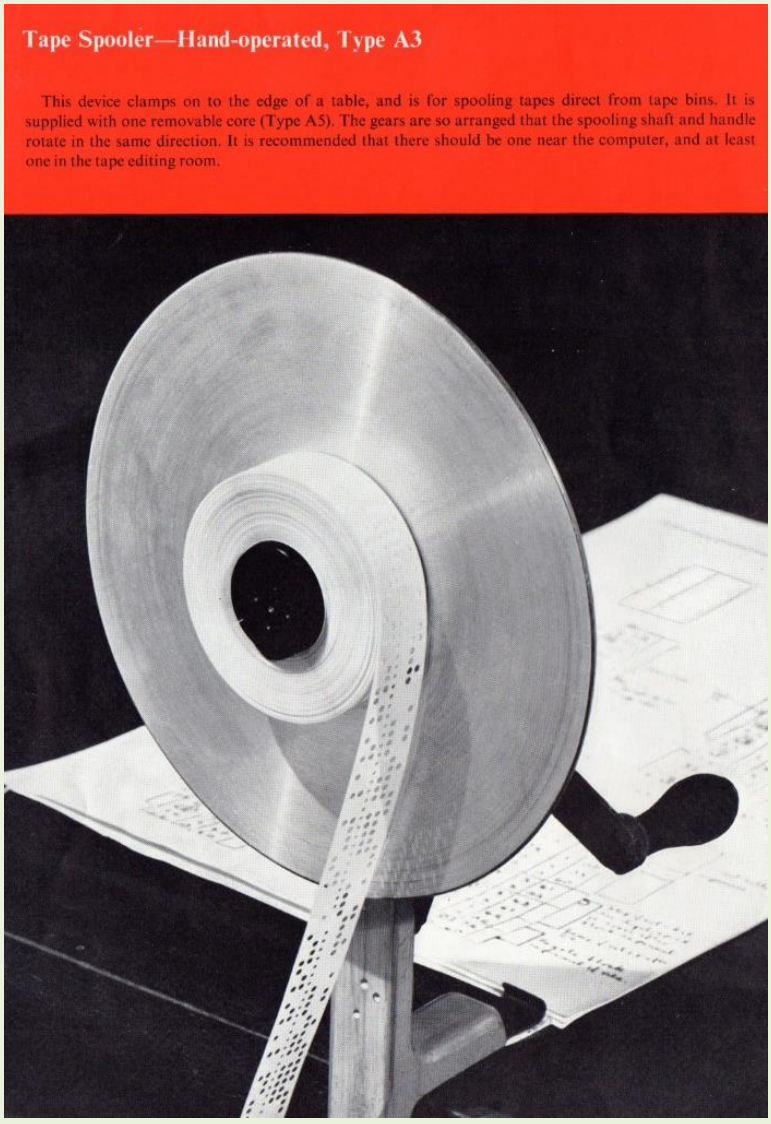
PREVIOUS ADDRESSES	Address	F	A	/ B	F	A	/ B	NOTES
	192	8	0	3				Not in use
	193	11	1		8	210		ENTRY S-R(i)
	194	11	1		8	200		ENTRY S-R(ii)
	195			=				Maximum estimated time = T_{max} ($\times 2^{-31}$)
	196			=				Actual time taken = T ($\times 2^{-31}$)
	197			$0				
202 →	198	11	1		3	220		
	199	9	245		8	207		Estimate too small
194 →	200	10	227		11	222		Store link of S-R(ii)
204 →	201	10	1		11	511		
	202	3	197		9	198		Measure T_1
	203	11	1		0	225		
	204	8	201					
	205			$32				
	206			=				$T_{max} - \lvert T_{max} \rvert_{16} + 32 = N$, number output
199 →	207	11	195		8	242		

(This is actually part of the program mentioned a few pages earlier for measuring the time taken for another program to execute). The full program sheets for the above program, the formal published specification of the program and other forms of the program can be seen from pages 16 to 25 on the website at

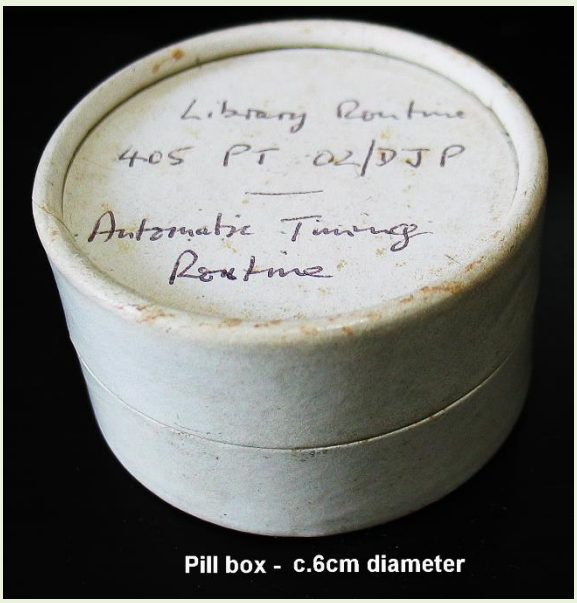
https://ourcomputerheritage.org/Maincomp/Eli/E2ExtraSoftware.pdf

Once written, the program sheets were given to an operator in the data preparation room, which had about eight electro-mechanical machines, (manufactured by Creed, as far as I recall). The operator would type from the written program sheets using a keyboard, and the machine would produce simultaneously a 5-channel paper tape. This would be the physical form of the program, which would be fed into the computer via a fast paper tape reader attached to the computer.

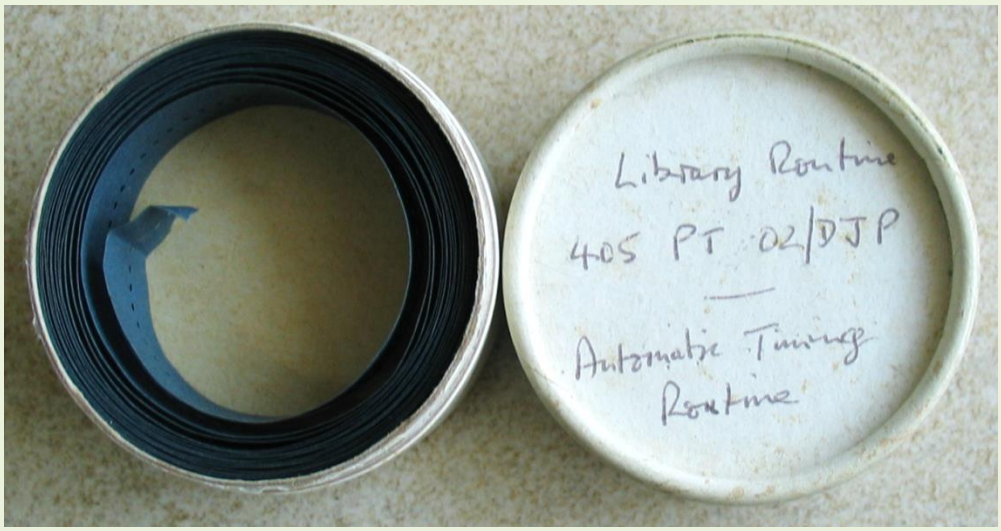
A newly prepared paper tape would emerge from the Creed punch machine, and fall into a large paper tape bin which stood on the floor next to the Creed machine. After completion of the paper tape, it would need to be wound up carefully, and for this, a hand cranked tape spooler was used. A photo follows, taken recently from an old Ferranti product manual:


Tape Spooler—Hand-operated, Type A3
This device clamps on to the edge of a table, and is for spooling tapes direct from tape bins. It is supplied with one removable core (Type A5). The gears are so arranged that the spooling shaft and handle rotate in the same direction. It is recommended that there should be one near the computer, and at least one in the tape editing room.

The master copies of the paper tapes were stored in cardboard pill boxes, which were available in various sizes. Below are photos of the above program's pill box, closed and open, showing the dark grey paper tape curled up inside.



Pill box - c.6cm diameter



For my ‘fun’ programs, I would use a Creed paper tape punch machine to type the program, preparing the paper tape myself.

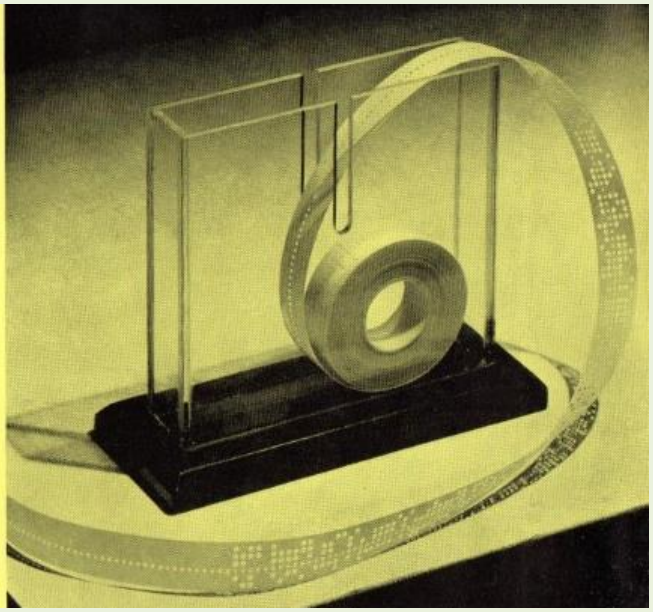
The paper tape would later be input to the computer by being fed through a paper tape reader. In 1962 I used a reader manufactured by Ferranti, which read at 100 characters per second. (Later, a much faster and more compact reader was manufactured by Elliotts, reading at 1,000 characters per second).

Paper tape read by a Ferranti or Elliott tape reader would have to be presented to the tape reader by a reliable method, so that it did not become tangled or torn. So it was suspended in a rectangular transparent Perspex trough, from which it could be safely pulled and read at high speed. Below is an example from a Ferranti brochure, although the picture does not show the correct method of using the trough, because the tape is shown resting on its base. At Elliotts, we suspended the tape reel from its centre using a short smooth metal rod which was lowered down the slit in the trough.

Tape Trough, plastic, Type A7

This plastic trough will hold spools of tape being fed into the tape reader of the computer or into the tape editing equipment. Spools of tape are usually dropped into this trough but, if the spools are very large, it is preferable to keep them in the tape boxes and place the boxes in the trough.

At least two tape troughs are recommended for each tape reader of a computer and three or four tape troughs for each set of tape editing equipment.

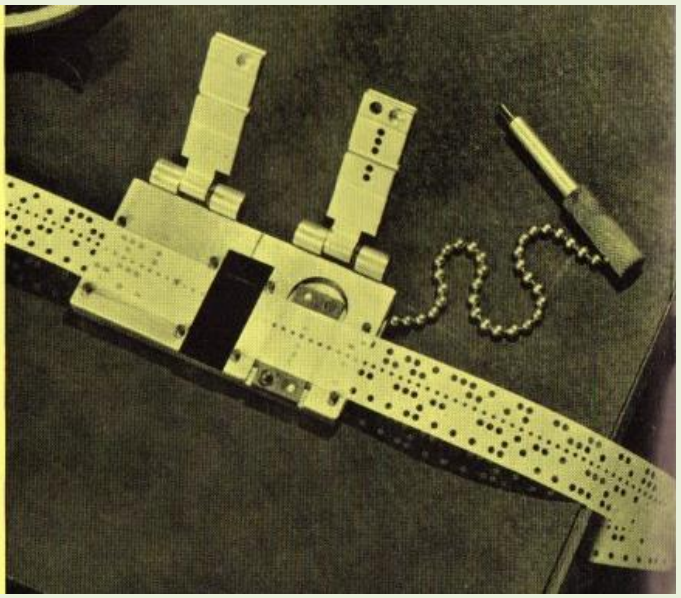


When testing a program, one would sometimes find an error on the paper tape. It could be a programming error, or an error in the original typing of the program. The standard way to deal with this, would be to feed the tape through one of the Creed machines, copying it up to the position of the error, type in the correction, and then reproduce the remainder of the tape. This was not a very quick process.

But occasionally it would be possible to correct the tape by a much quicker manual method in an emergency. There was a small device, which we called a uni-punch. One is shown below from the same Ferranti brochure, but they gave it a different name.

Tape Correcting Punch, Type A9

This is manufactured by Messrs. Creed & Co. and is used for punching additional holes when correcting punched tape. It is provided with a device which assists in splicing two tapes by means of adhesive tape. It is suggested that there should be one or two by the computer, one or two in the tape editing room, and one provided for each programmer.



It is fairly obvious from the above photo, how it was used. A metal flap was closed over the centre of the device, thus covering a small part of the paper tape. This flap had 5 holes drilled through it; and so did the metal surface beneath the metal flap under the paper tape. With a piece of tape held firmly on the uni-punch, the tiny cutting cylinder (attached to the chain) was pushed through the metal flap, and down through the tape into the base of the uni-punch, thus cutting a tiny circular hole in the paper tape.

The by-product of this procedure was a tiny disc of paper tape, which fell from the bottom of the uni-punch. If necessary, this tiny disc could manually be placed into a hole in the paper tape to fill up an unwanted hole; one used the smooth part of a finger nail to smooth the tiny disc into place, first from one side of the tape, and then from the other side, with the tape firmly pressed on to a hard smooth surface. This second procedure of filling up a hole was not very reliable, and one had to check after using the corrected tape that the hole was still filled up. Such a tape could not be repeatedly used, and the standard reproduction and correction process would have to be used later, to create a permanent re-usable tape.

I had to do all the above tasks, especially when a program was being developed. After a regular job went into production, it was normally run by operations staff, and we programmers would normally only be called upon when a difficulty arose.

But the major stock control project was special. Each computer run could take many hours, and computer breakdowns were quite common. I sometimes had to take over the running of a long job, because operations staff had to go home, or for whatever reason, were unavailable. This did not involve just sitting at the console and reading a book whilst waiting for a job to finish. The computer had to be monitored in several ways.

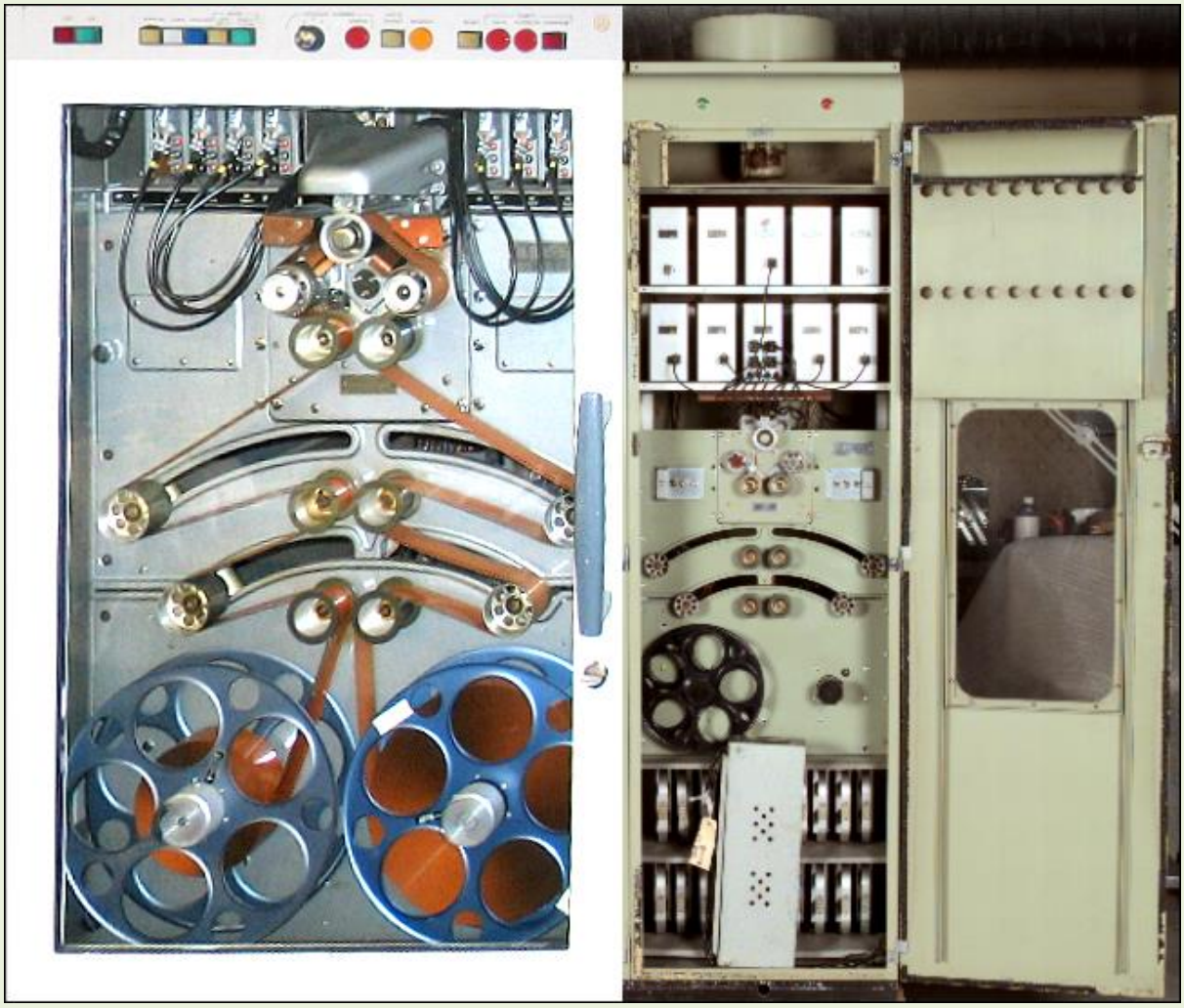
Each computer program had its own normal audible and visual characteristics, which one learned to recognise by sounds coming from the loudspeaker, and from the pattern of flashing lights on the console. A change in these signals could indicate that a problem may have arisen; a program might have ceased running, or it might be “going round in circles” abnormally.

Large scale data was stored on very long reels of 35 mm magnetically coated film, a medium which had been developed originally by Disney Studios for sound recording. Elliotts had I think decided to use this medium for storing data partly because of its strength, and because of its easy availability: the Elliott offices were very close to the Elstree and Borehamwood film studios.

(One of the film sets was next to Elliott’s car park opposite its main building, and sometimes I would walk over to see what was being filmed; I remember seeing on one occasion, small very realistic models of warships on a lake, which were being filmed as real warships).

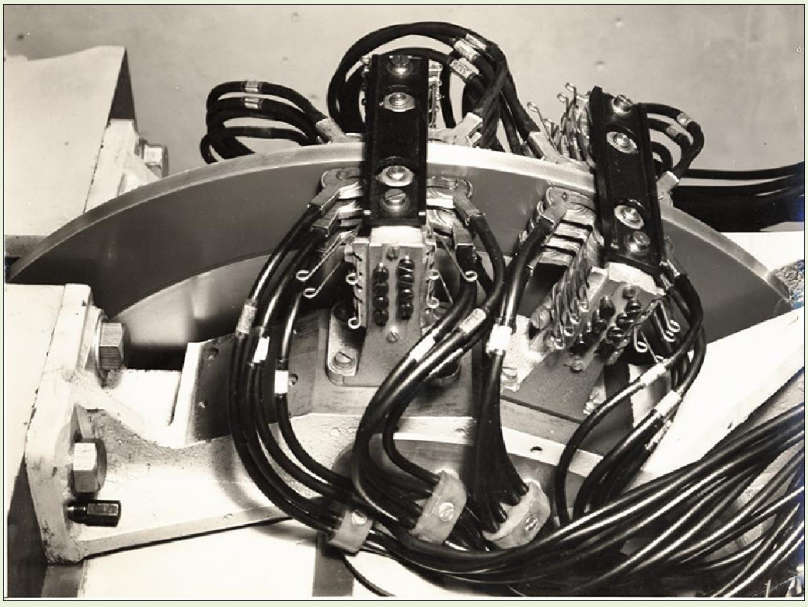
On the left side of the next page, is the only photo I have found of one version of an Elliott magnetic film deck, showing how a reel of film was wound around the servo mechanisms.

The servo mechanisms on the 405 (I do not know about on the 803) had a tendency to ‘drop out’, leaving the magnetic film slack, instead of taught around all the small metal reels. Anyone running a lengthy job on the 405 had to keep an eye on the film mechanisms, for early warning signs of the film’s becoming slack. A simple adjustment of a screw would enable the mechanism to be tightened up a little. That is one of the jobs which I did from time to time.



On the left is a film deck on an Elliott 803 computer. The mechanism is essentially the same as that on a 405 computer, which is shown on the right, but on the left you can see how the film was wound around moving servo mechanisms. The read/write head for transferring information from/to the magnetic film is above the topmost central circular mechanism. The 803 unit shown above, is held at the London Science Museum, and the 405 film unit is part of the computing equipment held at the Powerhouse Museum in Sydney, Australia.

Another important task was to monitor the state of the high speed disc. A photo of part of a disc unit is below.



You can see the top of the disc in the photo above. It revolved at very high speed, and from time to time we had to check the oil level and temperature to make sure that it was in a safe range; I have forgotten the exact temperature figures but they were something like 24-26c.

On one occasion, during early testing of the unit in the 1950s, the engineers did a safety test, deliberately speeding up the disc above its rated revolutions per second. The disc exploded, and parts of it penetrated a 23cm thick brick wall. The story of that test was passed down to 405 operators in subsequent years, and one or two were a little nervous, because the chair at which they sat in front of the control console, was directly in line with the revolving disc. I did not worry about it, but I was careful to check the disc regularly.

Computer programmers/operators who have worked in computing for many years, seem to have a favourite computer on which they worked, and often this is one of the early machines in their careers. Certainly for me, the Elliott 405 was my favourite, and the one about which I remember the most details. It had to be 'nursed along', sometimes, and one experienced a sense of triumph when a job completed successfully.

I am no electronic engineer, but I had watched engineers working on the computers, and I did learn enough to be able to deal with some problems. I remember that during one very late evening, the computer failed, and there was no engineer available. I was able to trace the fault to one section of fast memory. Memory was stored on what were called nickel delay lines, and at the back of part of the computer was a bank of such delay lines, each one with a handle, which was there to enable the unit to be pulled out. I first switched the computer off. Luckily there was a second 405 computer, switched off, next to the one I was working on, so I pulled out the same delay line from the second computer and installed it in the first computer. That solved the problem, and I completed the job.

******

To conclude this section of my work at Elliotts, readers may wonder about the monster computers of the 1950s, and wish they could see one functioning. Well, there is a short film available at the Yorkshire Film Archive, which in 2023 was still available to see.

The film was made in March 1959 depicting the delivery, installation and later subsequent use of the 405 installed at Reckitt's in Hull. The film was viewable by visiting www.yorkshirefilmarchive.com, and then doing a search using the term: NATIONAL 405 computer. Alternatively search Google for Yorkshire Film Archive, and do the same search. The film lasts for 13 minutes 38 seconds.

Unfortunately there is no sound track, so I have written a summary of the events shown, indicating the start time in minutes and seconds of each event. It is interesting to note not only the considerable logistical task of installing a business computer in the late 1950s, but also the rigorous method of data preparation, involving not just initial keying in of the data, but also its re-keying for verification, which was standard practice. *(In February 2011, the written commentary on the YFA website was inaccurate and incomplete).*

Here is a correct commentary on the events depicted in the film:-

9” General view of the computer, and then a paper tape being punched out, announcing the film, saying “N E 405 AT RECKITT’S”.

35” Three delivery lorries from Bullens arriving at Reckitt’s premises

1’12” Unloading the computer begins

1’36” The control console of the computer

1’44” Part of the air conditioning unit.

1’51” Some of the main cabinets being unloaded

2’41” A set of magnetic film cabinets being moved into the building.

2.54” Installing the memory, logic and film unit cabinets

3’27” The magnetic disc unit, and examination of same.

4’05” Installing the magnetic disc unit

4’48” Attending to circuitry

6’07” Connecting under-floor cables

6’15” The alternator set and control unit being lifted into the building

7’50” Engineers at work; the cabinet of equipment in front of the engineer in the foreground, is a standard 405 engineering test rig.

8’ Operating the console to load a paper tape (probably containing a computer program) into the computer

8’15” At the console controlling the operation of a program.

8’35” Four men at a meeting

8’45” Entrance to the programmers’ room

8’49” Chart analysing processing of daily cash

8’59” A programmer at work

9’26” Stage 1 of preparing numeric input data on a Creed paper tape punch machine.

9’50” Close–up of the paper tape punching mechanism

9’59” Verifying data – stage 2 of data preparation. The tape punched previously by the first operator is being read by the machine to the right of the keyboard, as the second operator keys in the same data again. If the machine detects a difference between what she types and the data already on the paper tape, the operator is warned, and she

makes a correction if necessary. The corrected paper tape is punched out on the machine to the right of the picture, and is then ready for input to the computer.

10’56” Collecting the input documents and the paper tape prepared from them

11’04” Putting the data tape into the Ferranti paper tape reader

11’20” Starting the program which inputs the paper tape data. The tape falls into a large bin, from which it is subsequently retrieved and rolled up into a reel, using a manually operated tape winder.

11.26” One of the magnetic film mechanisms, either reading a file of data or writing an updated file of data

11’34” The computer is punching out information on a Creed paper tape punch

11’39” Off-line Creed equipment. The computer has been instructed to print out one of its programs on the paper tape, which is now being read by the paper tape reader on the left, and the program is being printed at the typewriter at the right of the desk.

11’54” Some of Reckitt’s processed business information has been punched out by the computer on paper tape, and this is being read on the left of the picture by a paper tape reader. At the same time, the data being read, is printed out by the printer on the right. This data comprises order forms with lists of different products, quantities required, their unit prices (in old pence), and the amounts due (in £ s d).

12’22” Loading a magnetic film containing a file of data produced by the computer for subsequent printing. This is a separate piece of computing equipment, not directly connected to the main computer. Its function is to read large quantities of data from the magnetic film, and transfer the data to a line-at-a-time printer.

12’34” Operating the control console of the line-printing system to start the process of printing data from the magnetic film.

12’53” Printing business records on the line-printer on continuous stationery. The printer is thought to be a Bull line-printer, manufactured by the French ‘Compagnie des Machines Bull’.

MILLS ASSOCIATES LIMITED

Registered Office:
WOODSIDE HOUSE, THE GREEN, WINCHMORE HILL, LONDON, N.21
Telephone FOX Lane 0956

Temporary City Office:
10, MINORIES, LONDON, E.C.3
Telephone ROYal 4272

DMM/VGS/P

27th September 1962.

D.J. Pentecost Esq.,
Torrington Cottage,
Church Path,
Lodge Lane,
Finchley, N. 12.

Dear Mr. Pentecost,

I thank you on behalf of my brother for your application to join this Company. The salary we can offer is £1300. per annum.

With regard to the other points in your letter, there will be no objections, as we like to give our Senior Personnel as much freedom from administrative restraints as possible.

If you have any questions, I suggest you talk with Cedric or Pat. Also, could you give me an indication of your date of starting?

On behalf of the Company, I extend the hope that your career with us may be long and mutually satisfactory.

Yours faithfully,
MILLS ASSOCIATES LIMITED

D.M. Mills
Secretary.

DIRECTORS : - R. G. MILLS - A. J. BURTON - B. KENDALL -

Patrick Shackleton was to play a significant part in my early career development. (There is an appreciation of him at http://www.advinfo.co.uk/patrick.html, although a few details are not quite accurate). He was persuaded to leave Elliotts by R. G. (Gerry) Mills, who had been a programmer and later Elliotts' Sales Manager. Gerry Mills, a decade older

than me, was a hugely dynamic and brilliant man, and he had set up (I think late in 1961) Mills Associates Ltd, a software development company, based temporarily at 10 The Minories on the eastern edge of the City of London. Shackleton joined Mills in the autumn of 1962 after Gerry Mills had moved the company to Ship Tavern Passage, right in the heart of the City.

Ship Tavern Passage, probably in the 1950s (from Gracechurch Street)

The premises were on the first and second floors of a small building, right above the shop on the right with the arched entrance, in the above photo; in 1962 that shop was a coffee house/tea room. My office was on the first floor, in the photo shown apparently directly above the circular book shop sign. The premises were demolished and are now occupied by part of a chain of shops, I think Marks & Spencer. In the 1960s one could walk directly through Ship Tavern Passage under the first floor of the building in the background in the photo, into Lime Street, (which is just visible in the photo). But this

direct route to Lime Street no longer exists, and one has to turn left and then right to reach Lime Street.

At about the time when Shackleton left Elliotts, he asked me to join him at Mills Associates. I had been taken on at Elliotts a year or two before, as a junior programmer at a salary of £550 p.a. I was earning about double that by September 1962, as a senior programmer, and Shackleton had negotiated for me a starting salary at Mills Associates of £1,300 p.a. He told me a few months later that he regretted not having made it £1,500. I think he said that, because more members of staff had by then been recruited, mostly from ICT (International Computers and Tabulators) in Putney, and at least one employee was being paid about £1,500. Anyway, my pay was raised later. £1,500 for a young man in those days was a high salary, and I was delighted with it. It enabled me to buy, around 1964, a second hand two-tone green Riley 4/72 car for £650, which I used to drive to the City each day; in those days it was possible to make the journey from Finchley, using some backstreets, in a reasonable time. Mills had made an arrangement with a local multi-storey car park, for us to use some spaces free of charge.

Gerry Mills had persuaded another Elliott employee, Cedric Dennis, also to leave Elliotts. The exodus of staff from Elliotts to Mills, caused a row between the two companies, and I think Cedric had to leave Mills Associates. Cedric knew one of the senior secretaries who worked at a firm of accountants near Liverpool Street Station, called Prince, Simon & Co. It was through Cedric, that Mills Associates gained a contract to assist Prince, Simon & Co. in the launch of a new unit trust called The Property Share Unit Trust. Mills Associates had to develop software in a hurry, to enable the unit trust administration to be computerised. I think it may have been the first unit trust in the UK to make extensive use of a computer system. I was put in charge of a small team, reporting to Shackleton (who had defined how the computer system would work), tasked with the software development – my first experience of being in charge of other people.

The unit trust software was to run on a service bureau computer at the premises of De La Rue Bull, who had offices in Southampton Row. (For use of the bureau, we negotiated with the managing director, Ian McNaught-Davis, who was also a well-known mountaineer. He later became a TV presenter, best known for presenting the BBC television series The Computer Programme, Making the Most of the Micro and Micro Live in the 1980s). I had the use of Mills Associates' bright yellow Triumph Herald, to travel to and from Southampton Row. The computer was known as the Bull Gamma 30, but it was in fact an American machine called the RCA 301. It was marketed in France as the Gamma 30, and in the UK as the ICT 1500. That computer was to form the basis of all software development in Mills' office in London. My small software team was only one of two or three teams of programmers in that office; they too worked on writing software for other projects to operate on the ICT 1500, which was becoming a popular computer.

I have mentioned Mills' London office. The company had also set up an office in Monmouth, where Gerry Mills was mostly based, and for which programmers were recruited locally. The major project in Monmouth was providing support for a Welsh steel company; Mills bought an Elliott 803 computer in 1962, and set up a service bureau in Monmouth, providing services for the steel company. At least one other office of Mills

Associates was later set up, in Hemel Hempstead, which I think was still operating in the 1990s. The Elliott 803 became the best-selling UK computer, and over 200 were installed between 1962 and 1966. Mills Associates bought two 803s. I attended an 803 programming course whilst at Elliotts, but I did not have the opportunity to develop any software for that machine.

My unit trust project had a deadline to meet. The Property Share Unit Trust was scheduled for launch to the general public in March 1963, via advertisements in national newspapers, where application forms to buy units were printed. Prince, Simon & Co. had set up a company called Unit Trust Services Ltd, to administer the unit trusts which they planned to launch.

Over 4,000 application forms were completed and posted to the offices of Unit Trust Services (UTS), which were at 16 Coleman Street, just off London Wall in the City. (I seem to remember that the exact number was 4,124).

The units were priced for the launch of the unit trust at 5/- (five shillings - 25p today) each, with a minimum purchase amount of £50, i.e. 200 units. The offer of units to the public was known as a 'block offer', and the advertising would announce the availability for sale of a block of, say, 2 million units in the trust.

For a period of one or two weeks, post arrived at 16 Coleman Street, containing the completed small application forms cut from the newspapers, with cheques in payment. The applications came either directly from the investing public, or from banks and other professional organisations who were acting as agent for the applicant. In the latter cases, the agent's stamp had been applied to the form. UTS staff had the task of checking the validity of the forms and cheques, and banking the money. Mills Associates' office and the UTS office were not far away from each other, and I worked closely with the UTS staff and with the data preparation staff, supervising the technical aspects of the processes involved.

The processes are described in the article below, which I wrote for the magazine Data and Control, published in June 1963. (I did not choose the awful title or write the text at the top of the second page).

In the first of the three magazine pages below, the photo shows the Gamma 30 computer at De La Rue Bull's service bureau in Southampton Row, which was close to the Bonnington Hotel which is still there today. Coincidentally I recognised one of the staff there (shown in the photo), as Rupert Bayfield, who was a schoolmate of my brother Edward. In the second of the three pages, the girl in the photo is one of my team of programmers – Rosemary Sibley. She was one of several staff recruited by Mills from ICT in Putney.

D J Pentecost

SURMOUNTING THE PEAKS

in data processing demands

IN November 1962 the Computing Service department of Mills Associates Ltd was commissioned by Unit Trust Services Ltd to formulate a system for the administration on a computer of the Property Share Unit Trust.

They undertook the system specification, the writing of programs, operation of the computer for production runs and the handling of output documents. The system design and program writing and testing for the block offer were completed in three months by a staff of three. Punching of the input data on paper tape was carried out by Datacentre Ltd.

The machine chosen was the Gamma 30 computer in the London Service Bureau of de la Rue Bull Machines Ltd; this computer is now being used in the administration of the Trust.

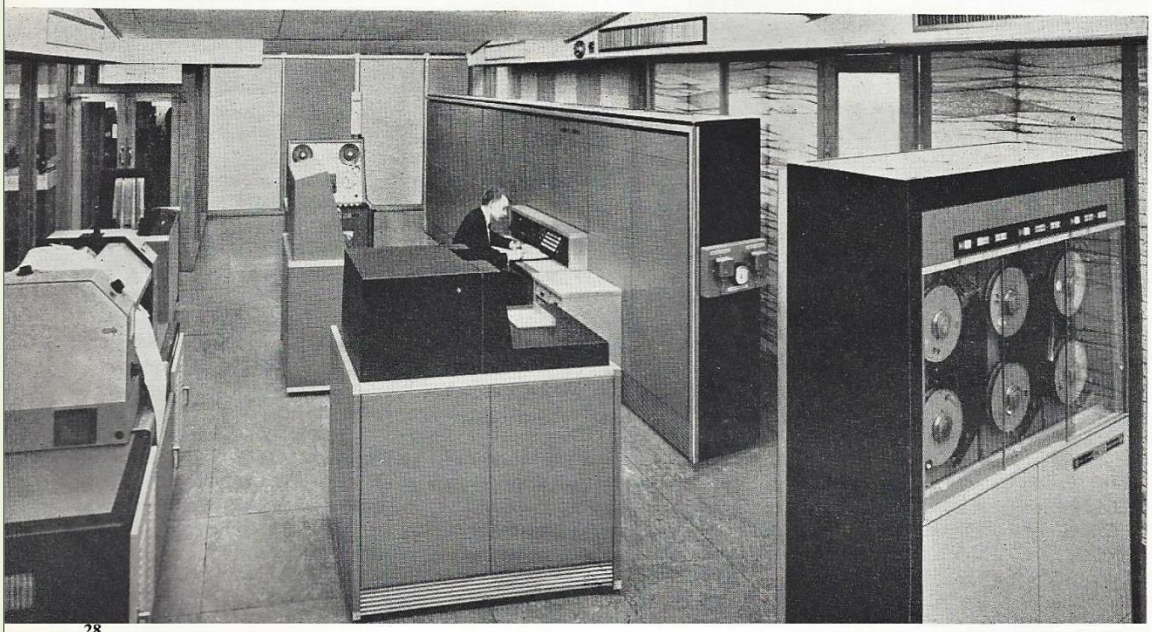
THE BLOCK OFFER

The block offer of Trust Units was advertised nationally, and over 4,000 applications for units were received. Throughout the period of the offer, between the 21st and 29th March 1963, data was punched on paper tape each day and was processed by the computer during the same evening. At the end of the period further operations were carried out for the production of the main results.

The output comprised:

1 Proof lists
2 Acknowledgment postcards } each day of the offer
3 Cash list analysis
4 Issued Sheet No. 1
5 Certificates
6 Name and address labels
7 Register Sheet No. 1
8 Advertising analysis
9 Agents' commission reports.

The Gamma 30 at De La Rue Bull Machines Ltd London Service Bureau in Southampton Row. This American designed computer is now being manufactured in Bull's recently opened factories in the Loire valley.



Any business which experiences irregular peaks when large volumes of information need rapid and accurate processing may have a need for a bureau computer.

Unit trusts experience such a need. They are also committed to heavy bills for duplicated printing which is enforced by statute. Unit Trust Services Ltd have overcome these and other snags in administering a nationally advertised block off of trust-units by using a Gamma 30 at the De La Rue London Service Bureau.

DATA INPUT—NO VERIFICATION

As the application forms arrived, they were inspected, allocated a serial number (later to be used as the certificate number), batched and totalised by the managers on cash lists for banking purposes; this totalising also served as a check on computer accuracy at later stages of the process. The forms were then edited if necessary before being passed to the punch operators.

The data punched from each application form consisted of:

Serial number
Number of units applied for, and amount of money (for reconciliation)
Name and address of applicant
Newspaper advertisement code
Names of joint applicants, if any
Name and address of agent, if any.

The apparently risky decision not to follow the punching of paper tape by verification was taken for the following reasons:

1. The techniques for verifying paper tape are only satisfactory if the data is clearly transcribed on to properly-designed punching documents. By contrast, the unit trust data is mainly handwritten by private inviduals on pieces of newspaper and consists of variable length alphanumeric fields. Transcription of this data on to special punching documents would have been too time-consuming, and transcription itself would have introduced errors.
2. To an auditor, the mere existence of a paper tape, albeit a verified tape, is not sufficient proof of the accuracy of the data on it; still less is the existence of a magnetic tape produced from the paper tape. It is therefore necessary to prove that the data is correct, when it is actually stored on the magnetic tape file.

INSTEAD OF VERIFICATION . . .

1. Every possible automatic check on the data was included in the programs.
2. Input was stored on magnetic tape files, initially on an 'unconfirmed' file and subsequently on a 'confirmed' one, data being copied from the one to the other only on receipt of a positive instruction from the Trust Managers' staff after they had examined the proof list, this being a print-out from the unconfirmed file of the input data (see next section).
3. The input each day was therefore of three types: confirmations of previous input, corrections of previous input, and new applications from the public. The total amount of data repunched as corrections was 20 percent of the data punched as new applications.

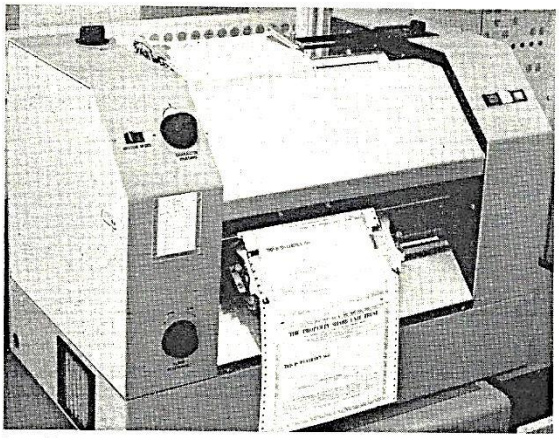
'The Share certificates for Unit Trust Services Ltd being printed on the Gamma 30 Anelex line printer. Computer bureaux are providing economical solutions to many one-off or peak processing problems.'

OUTPUT—PROOF-LISTING

The two kinds of output printed each evening during the block offer period were postcards acknowledging receipt of the applications, and a proof list.

The computer printed the names and addresses of the applicants on the postcards, which were franked and posted next day, one day after receipt of the applications.

The proof-listing process replaced the conventional system of data verification before input. The proof list is simply an orderly print-out from the unconfirmed magnetic tape file of the data on the input paper tapes; it also contains indications of all errors detected by the computer during input. Each day the proof list has to be inspected and compared in detail with the application



Proof lists and acknowledgment postcards and cash list analysis were printed out during the evening for all applicants. The final share certificates were printed at the end of the period.

forms. The incorrect records are then re-punched and input again on the next computer run before the normal daily input of new applications; the computer uses the serial number to identify the records on its existing file which have to be corrected.

SORTING

After the block offer closed, and all the applications had been stored on a magnetic tape file, the computer sorted the file by unit-holders' names into alphabetical order. A sorting key was constructed by the computer from the name of each applicant during the input process and generally this consisted of surname followed by forenames. Special sorting keys were formed for peculiarities such as double-barrelled surnames, names of organisations, etc.

ALLOCATION OF ACCOUNT NUMBERS

The computer then allocated an account number for each applicant; thus the present file is in both alphabetical and account number sequences; the account numbers have been distributed throughout the range of numbers one to one million so that details of new unit-holders may be inserted into the file without upsetting these sequences. The account numbers provide an easy and accurate method of referring to the details of any unit-holder's transactions, and have been chosen in such a way as to reduce the danger of reference to a wrong record on the file. The accidental alteration of any one digit of an account number, or the transposition of any two digits, is always detected by the computer, and 92 percent of other errors are detected.

MAJOR OUTPUT

The file was now ready for the major block offer output programs to be obeyed. The first of these programs printed copies of the Issued List, being a print-out from the file of names, account numbers, certificate numbers and the numbers of units held; this list is required by the Inland Revenue, the Trustees and the Trust Managers. Next the certificates were printed; in the cases where one preson had made more than one application for units, the applications were amalgamated, and only one certificate was printed. Sheets of labels bearing names and addresses were produced for posting the certificates to the unit-holders. These printing operations occupied a total of about two hours' computer time.

Paper tape punching without verification, as input to a computer system is economical despite the high cost of computer time—this is one of the main practical points which Unit Trust Services Bureau application has made clear.

ANALYSIS

An agents file was then constructed from the main unit-holders' file, consisting of the selected records of all applicants whose purchases were conducted through agents.

At the same time, a table of totals was formed of the number of applications and number of units purchased for each occurrence of a distinct advertisement code; this table was output to show the proportion of investment obtained through each newspaper and journal in which the application forms were published.

Finally the agents' file was sorted by agent's name and address; the resulting sorted file was then analysed and a list printed of all applicants for each distinct agent. Each agent receives commission, being a percentage of the total value of the units which he purchases for his clients; this commission was calculated and output.

At any stage after completion of the input (for example before or after sorting, before or after account number allocation) it is possible to perform a cash list analysis on the file. This shows the number of certificates and total number of units for each of the cash list batches which were prepared manually before input.

FILE MAINTENANCE

The unit-holders' file is being maintained on an historical basis, records being stored of all transactions, *ie* sales, purchases and amendments (such as changes of address). Computer runs to update the file may be carried out at any time, but initially are to be monthly.

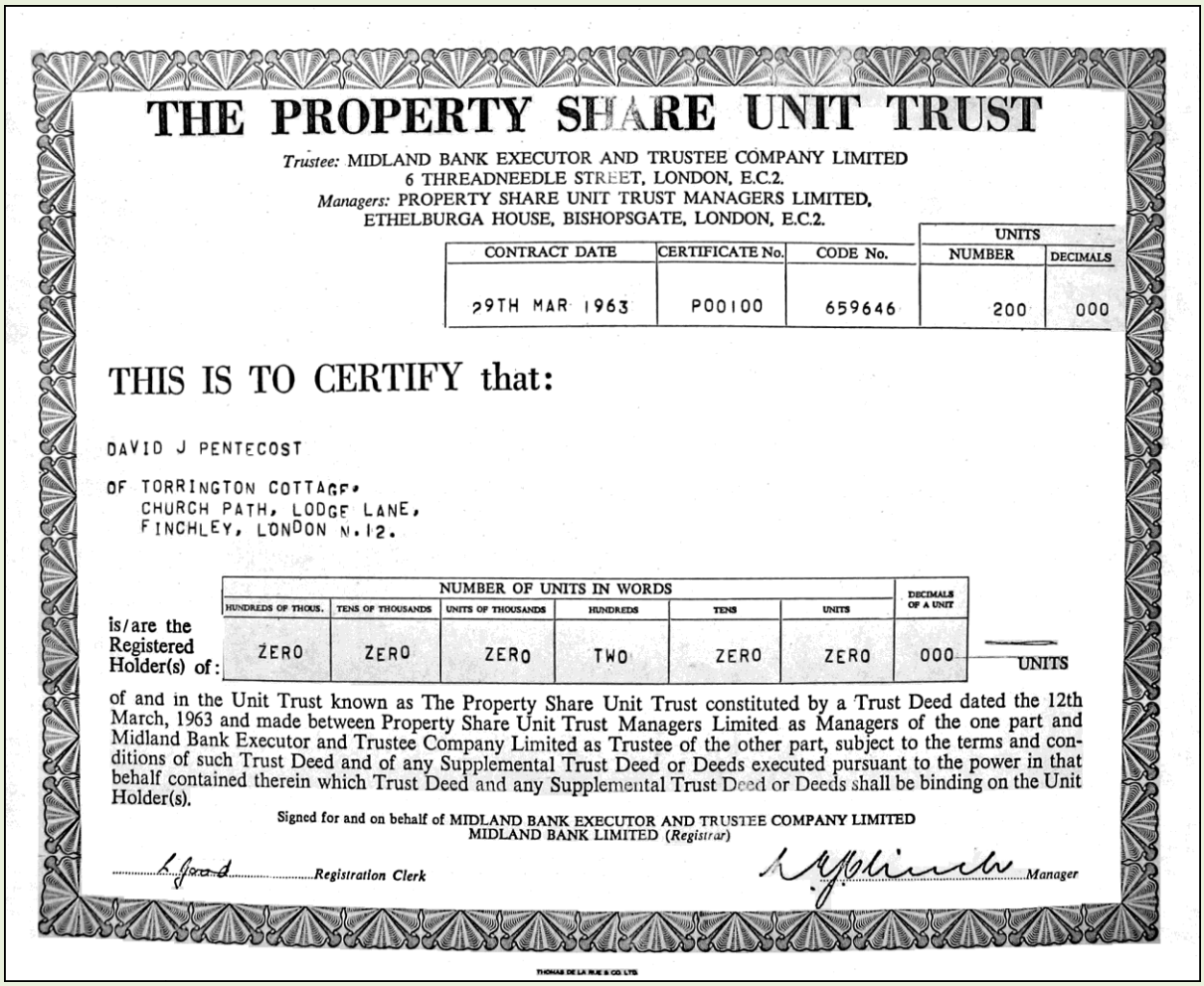
Details of all transactions are input, and cause output of a new register sheet for each unit-holder concerned. The new register sheet shows not only the current transaction, but also all previous transactions.

If the transaction is an amendment, the only resulting output is the register sheet; sales by unit-holders are shown on the Cancelled Sheet, which lists all such sales since the previous computer run. Purchases by unit-holders produce two kinds of output: certificates and an Issued Sheet, which shows all units issued since the last computer run.

The programs also make provision for adminstering a Savings Scheme for unit-holders who wish to invest amounts regularly. The savers' account numbers and amounts invested are the computer input each month, with a Savers' Allotment Sheet as output, which lists all units alloted to savers. Every six months, a certificate is output for each saver for the total number of units allotted to him throughout the previous six months.

Each year the computer analyses all units by the date on which they were issued, in order to produce the grouping which distinguishes capital from income; this is necessary for calculation of the dividend. The computer is used to print a dividend warrant and a counterfoil for each unit-holder.

I bought some units in the Property Share Unit Trust, and below is the certificate of ownership, number 100, which I arranged to allocate to myself.



THE PROPERTY SHARE UNIT TRUST

Trustee: MIDLAND BANK EXECUTOR AND TRUSTEE COMPANY LIMITED
6 THREADNEEDLE STREET, LONDON, E.C.2.
Managers: PROPERTY SHARE UNIT TRUST MANAGERS LIMITED,
ETHELBURGA HOUSE, BISHOPSGATE, LONDON, E.C.2.

CONTRACT DATE	CERTIFICATE No.	CODE No.	UNITS NUMBER	UNITS DECIMALS
29TH MAR 1963	P00100	659646	200	000

THIS IS TO CERTIFY that:

DAVID J PENTECOST

OF TORRINGTON COTTAGE,
CHURCH PATH, LODGE LANE,
FINCHLEY, LONDON N.12.

is/are the Registered Holder(s) of:

NUMBER OF UNITS IN WORDS						DECIMALS OF A UNIT
HUNDREDS OF THOUS.	TENS OF THOUSANDS	UNITS OF THOUSANDS	HUNDREDS	TENS	UNITS	
ZERO	ZERO	ZERO	TWO	ZERO	ZERO	000

UNITS

of and in the Unit Trust known as The Property Share Unit Trust constituted by a Trust Deed dated the 12th March, 1963 and made between Property Share Unit Trust Managers Limited as Managers of the one part and Midland Bank Executor and Trustee Company Limited as Trustee of the other part, subject to the terms and conditions of such Trust Deed and of any Supplemental Trust Deed or Deeds executed pursuant to the power in that behalf contained therein which Trust Deed and any Supplemental Trust Deed or Deeds shall be binding on the Unit Holder(s).

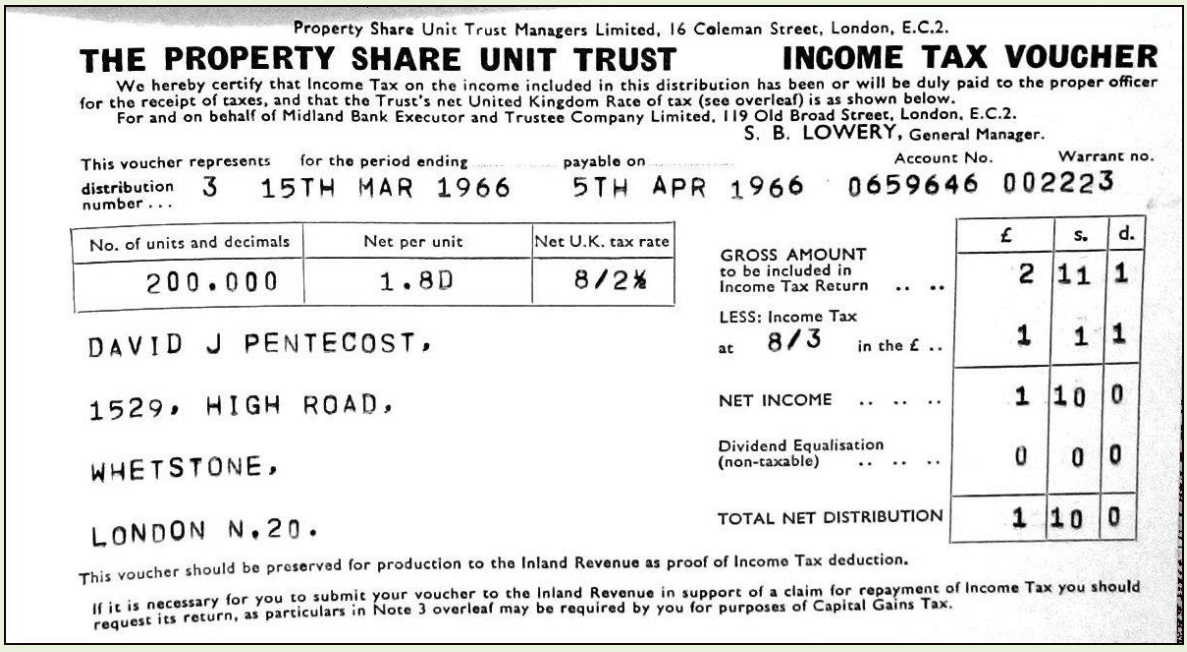
Signed for and on behalf of MIDLAND BANK EXECUTOR AND TRUSTEE COMPANY LIMITED
MIDLAND BANK LIMITED (*Registrar*)

Registration Clerk *Manager*

THOMAS DE LA RUE & CO. LTD.

One of the first unit trust certificates printed by computer in U.K.

Below is an example of an income tax voucher, which we printed for each unitholder for each distribution of income periodically.



Property Share Unit Trust Managers Limited, 16 Coleman Street, London, E.C.2.

THE PROPERTY SHARE UNIT TRUST — INCOME TAX VOUCHER

We hereby certify that Income Tax on the income included in this distribution has been or will be duly paid to the proper officer for the receipt of taxes, and that the Trust's net United Kingdom Rate of tax (see overleaf) is as shown below.
For and on behalf of Midland Bank Executor and Trustee Company Limited, 119 Old Broad Street, London, E.C.2.
S. B. LOWERY, General Manager.

This voucher represents distribution number ... 3 — for the period ending 15TH MAR 1966 — payable on 5TH APR 1966 — Account No. 0659646 — Warrant no. 002223

No. of units and decimals	Net per unit	Net U.K. tax rate
200.000	1.8D	8/2½

DAVID J PENTECOST,
1529, HIGH ROAD,
WHETSTONE,
LONDON N.20.

	£	s.	d.
GROSS AMOUNT to be included in Income Tax Return	2	11	1
LESS: Income Tax at 8/3 in the £ ..	1	1	1
NET INCOME	1	10	0
Dividend Equalisation (non-taxable)	0	0	0
TOTAL NET DISTRIBUTION	1	10	0

This voucher should be preserved for production to the Inland Revenue as proof of Income Tax deduction.

If it is necessary for you to submit your voucher to the Inland Revenue in support of a claim for repayment of Income Tax you should request its return, as particulars in Note 3 overleaf may be required by you for purposes of Capital Gains Tax.

Unit trusts became very popular with the public as investments over the next several years, and new unit trusts were set up, not only by UTS, but by other unit trust management companies, and by the big banks. Prince, Simon & Co's unit trusts were in due course put under the umbrella of Target Trust Group, but were still administered by Unit Trust Services Ltd. Some companies wanted to set up their own unit trusts but did not have the experience and skills or computer systems to carry out the administration themselves, so UTS began to bid to carry out the work on their behalf. I recall three of these companies immediately: one was Slater Walker, who had a huge reputation nationally and in the City as financial whizz kids; another was one of the 'big four' UK banks, (whose identity I had better not reveal, and will refer to from now on as Bank X) who were to set up more than one unit trust; and the third was the Trustee Savings Banks organisation (TSB).

Whilst at Mills Associates, I worked closely with UTS for about two years. Then Gerry Mills closed his London office, and arranged for the staff from that office to become employees of International Shipping Information Services Ltd (ISIS), as from 26th May 1964. ISIS had set up a computer service bureau, a few yards from Ship Tavern Passage, at Forum House, 15-18 Lime Street, which still exists today, although it has been extensively modernised:

Forum House, 15-18 Lime Street, August 2018

I visited Forum House whilst on holiday in August 2018, where the above photos were taken. When I worked there, on the left, inside the entrance hall, stood the building's liftman, who always had a cheerful smile on his face; he opened the noisy folding metal gates, and took us up to whichever floor we wanted.

In the photo above, (from Google, September 2018) you can see Forum House on the left, and a clothing shop on the ground floor, which in the 1960s was our computer bureau, which could be seen through the windows. It was possibly the first such bureau in the City of London.

In June of 1964, I, with all other Mills Associate shareholders, was obliged to sell my shares back to the company's founders, for £3 per share, which must have meant that I made a profit of £2 per share. How many shares I had bought on joining the company I do not remember, but it was probably not more than 250.

We moved into the Lime Street premises, where an air conditioned computer room had been constructed for an ICT 1500 computer, as the workhorse for the ISIS bureau. The unit trust computer systems thenceforth operated from Lime Street, rather than from Southampton Row.

Next to Forum House, you can see in the three photos above, a pub called The Grapes. In the 1960s it was known as The Bunch of Grapes. Inside it has barely changed at all. The black and white photo is said to be of some bankers in the pub, possibly in the 1960s, and next to it, is me in August 2018. Some Mills Associates and ISIS employees used to frequent the pub; I joined them occasionally, but rarely drank anything alcoholic.

ISIS were developing a system to create and maintain a register of international shipping, (based on Lloyd's Register of Shipping which had been published since the 18th century)

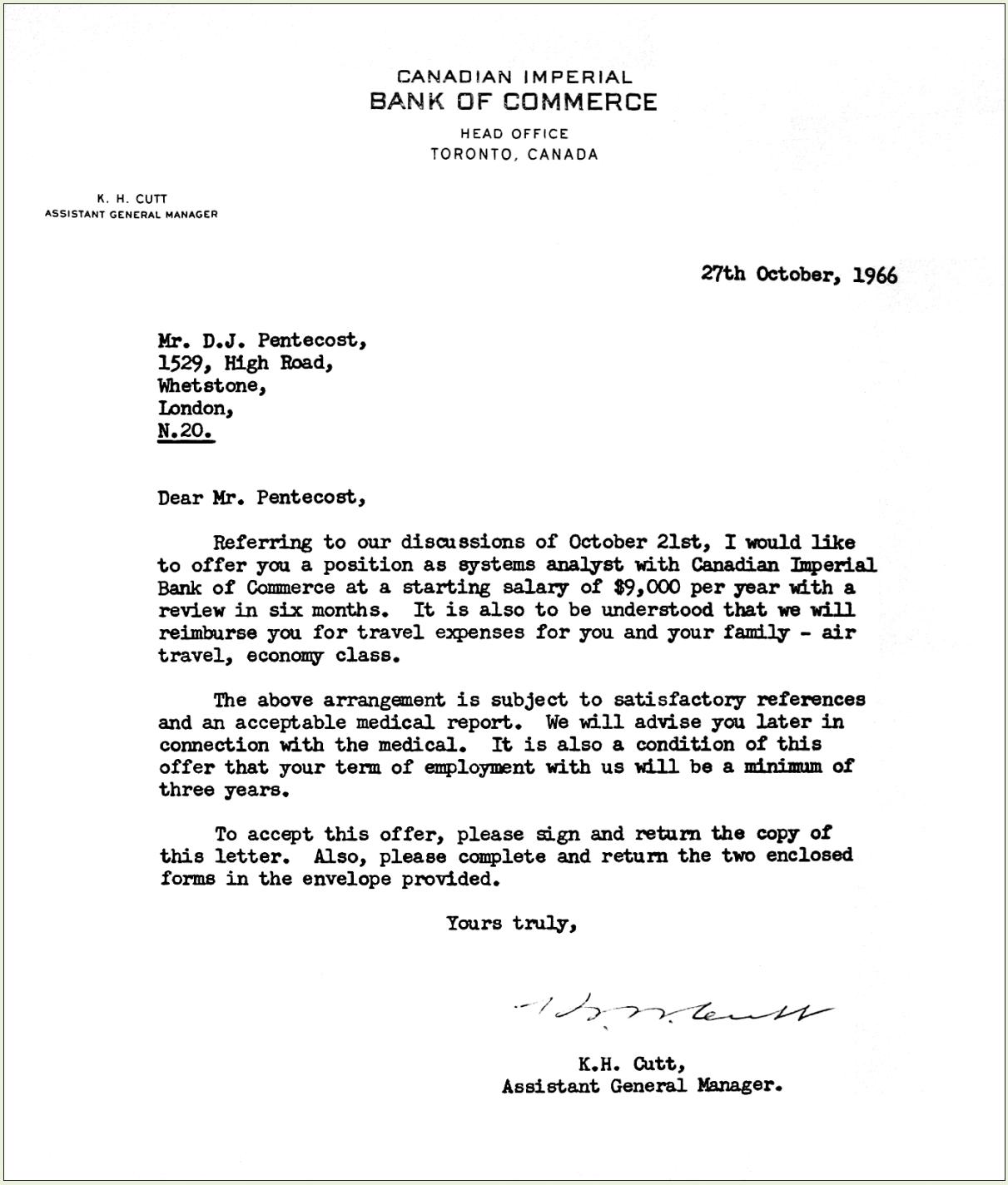
and to make the database available to anyone in the shipping industry, to enquire about any registered ship, for a fee. I was not involved in this system, and a lot of effort was put into developing it, but as I recall, there seemed to be no real market for the services. ISIS was I think in financial difficulty as a result, and was taken over by the nearby British and Commonwealth Shipping Company (B&C).

Over approximately the next year, I undertook the task of writing a major element of B&C's payroll system, which they wanted to have computerised, to run on the ISIS computer. I was part of a team of five or six people. I spent a good deal of time at the nearby B&C offices, specifying how the hugely complex, antiquated and sometimes illogical payment rules, (which had developed over many years resulting from negotiations with ship workers' unions) could be specified for programming.

At some point, the systems and programming staff, including me, moved out of the Lime Street offices into premises, newly built, or perhaps just refurbished internally, just south of the Thames, at 67 Southwark Street, at the junction with Lavington Street. The computer bureau and the operating staff remained in Lime Street. A photo of these Southwark Street offices is below, taken by Google in July 2016; extraordinarily, by September 2017 the building had either been stripped to its steel and concrete frame, or demolished, and a new building was going up.

67 Southwark Street

Around the middle of 1966, I started looking around for another job, and on 21st October I had an interview in London for a job in Toronto, Canada, with the Canadian Imperial Bank of Commerce.



CANADIAN IMPERIAL
BANK OF COMMERCE
HEAD OFFICE
TORONTO, CANADA

K. H. CUTT
ASSISTANT GENERAL MANAGER

27th October, 1966

Mr. D.J. Pentecost,
1529, High Road,
Whetstone,
London,
N.20.

Dear Mr. Pentecost,

Referring to our discussions of October 21st, I would like to offer you a position as systems analyst with Canadian Imperial Bank of Commerce at a starting salary of $9,000 per year with a review in six months. It is also to be understood that we will reimburse you for travel expenses for you and your family - air travel, economy class.

The above arrangement is subject to satisfactory references and an acceptable medical report. We will advise you later in connection with the medical. It is also a condition of this offer that your term of employment with us will be a minimum of three years.

To accept this offer, please sign and return the copy of this letter. Also, please complete and return the two enclosed forms in the envelope provided.

Yours truly,

K.H. Cutt,
Assistant General Manager.

As can be seen in the letter above, the bank subsequently offered me a post, for a minimum period of three years, as a systems analyst at a starting salary of C$9,000, with a review after 6 months. I decided not to accept the job, for reasons which I cannot now remember, but perhaps because of the uncertainties involved, and perhaps because of the minimum term of three years, during which period housing would have to be arranged.

Chapter 5: DATACO LIMITED

Early in 1967 I was continuing to seek other employment, and I arranged to be interviewed on 3rd March at ICT's offices near Putney Bridge. On 22nd March I received from them a job offer as a software planner at £2509 p.a., and I replied that I was almost certain to accept the offer, but had to await the outcome of another possible job interview. On 30th March I wrote, declining the ICT offer.

CONTRACT OF EMPLOYMENT

DATACO LIMITED

DAVID J. PENTECOST

The general conditions of employment will be as follows:-

Nature of Employment CONSULTANT

Salary

£2700 per annum paid monthly in arrears.

Holidays

The normal holiday entitlement will be three weeks, exclusive of public holidays.

Hours of work

The work week, Monday to Friday, will be of 37½ hours duration and between the hours 8.30 a.m. to 6.30 p.m.

Pay During Sickness

In the event of sickness or incapacity the Company will, on receipt of satisfactory medical certificates, make payment as follows:-

1. For the first six weeks in any year - full pay less any National Insurance Benefit received.

2. For the second six weeks - half pay less any National Insurance Benefits received.

3. For any further absence - to be dealt with at the Company's discretion.

Confidential Information

All matters connected with the Company's business and that of its clients will be treated as strictly private and confidential and not disclosed to any third party.

Termination

This contract may be terminated by three months' written notice on either side.

Employee's signature D. J. Pentecost ..... Date 3rd April 1967

For Dataco Limited ..... Date 31st March 1967

One of my colleagues at Elliotts had been Harry Lawrence, who much later moved to live in the USA, I think in Boston. An attempt had been made by Gerry Mills to poach him

away from Elliotts, but the attempt was blocked by Elliotts. Harry left Elliotts, and I am not sure where he went, but at some later date, possibly late in 1966, I became aware that he had a consultancy company called ELF, somewhere in the north of England.

At the time when I was applying to ICT in Putney, Harry called me one day out of the blue, offering me a job with Dataco Ltd, a company set up I think by Patrick Shackleton, with Harry having been appointed Managing Director. I accepted the post of Computer Consultant at £2,700 p.a. I cannot recall exactly where their office was – but it was in the Clerkenwell district of London. The company went into liquidation in October that year, and I cannot recall having achieved anything positive during that five month period, except to define for the company the format of computer program specifications which we would all adhere to. I do recall having attended some meetings with Shackleton or Harry at potential clients' offices, to bid for a few new contracts, but we did not succeed in winning any of them as far as I can recall.

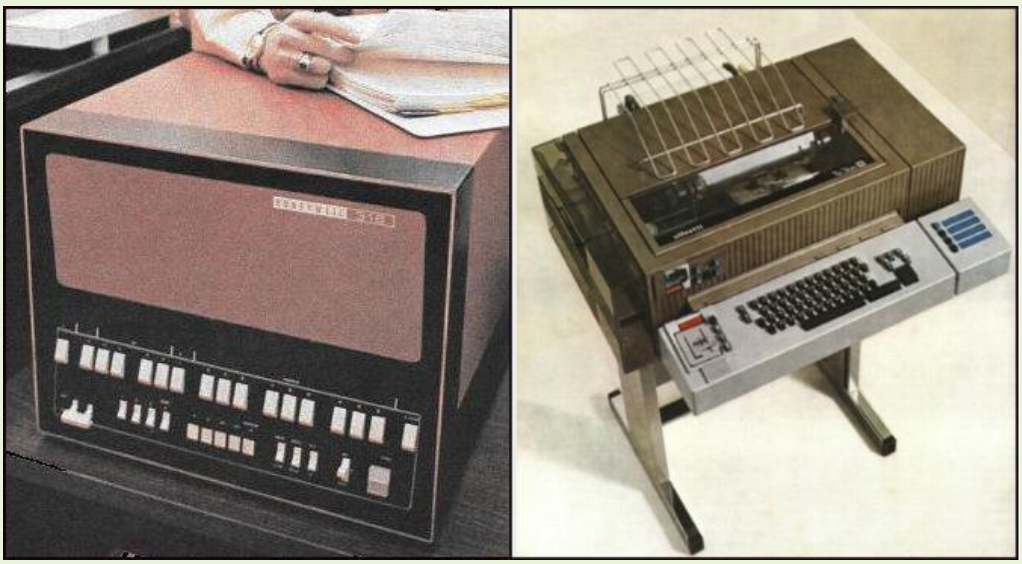
Chapter 6: UNIT TRUST SERVICES LTD (UTS)

I had holdings in a few unit trusts run by UTS, and one day, in October 1967, before Dataco liquidated, I had a problem regarding one of my holdings, which required me to telephone the UTS office manager, whom I knew. He responded by inviting me to come to 16 Coleman Street – a small building which no longer exists. I gathered that at some point in the previous two years, they had moved their unit trust work away from the ISIS bureau, to another bureau, ITT Computer Services in Cockfosters, which had redeveloped the unit trust software, to perform on an IBM computer almost exactly the same functions as the system which I had been in charge of developing, and which had operated at ISIS and earlier at another bureau.

Michael Prince, the Managing Director of UTS, wanted to talk to me whilst I was at 16 Coleman Street, and he explained that UTS needed a better system to produce contract notes for the sale and repurchase of units. Such notes had always been produced manually, using electric typewriters on very wide multi-part sets of paper, with a large backing sheet which formed a listing of all the contract notes typed. It was a messy and difficult process, and it needed to be automated.

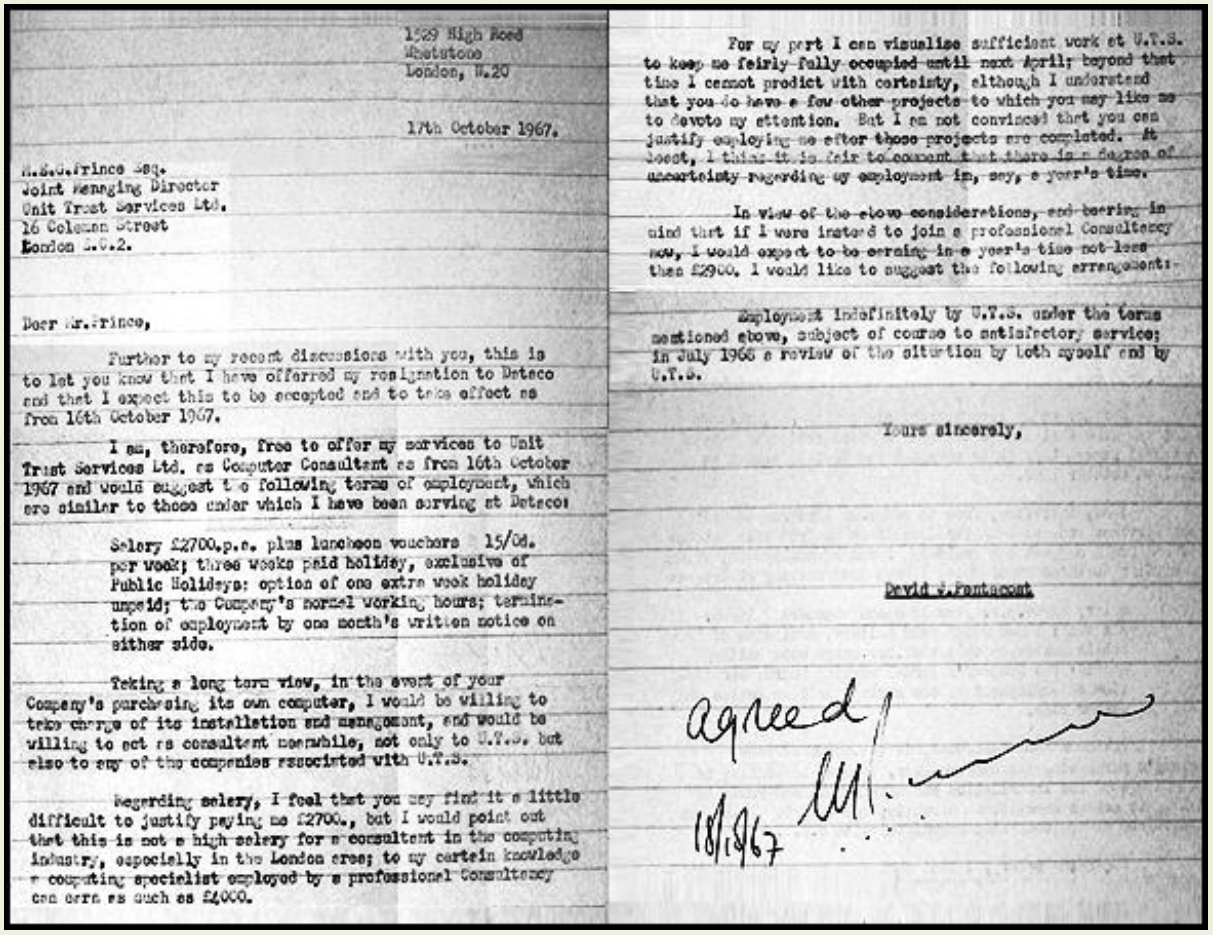
He subsequently asked if I would be interested to join UTS as an employee, to manage all computing aspects of the company. We exchanged correspondence, (see next page) and I was taken on as Computer Consultant at a salary of £2,700 p.a., the same as I was earning at Dataco. This was with the agreement of the liquidators of Dataco.

When I started at UTS, I found that investigation of automating the production of contract notes was already under way. UTS were talking to Burroughs about using an electronic calculating typewriter. I took over this embryonic project and kept running into technical difficulties while developing a system specification; the machine was simply not capable of doing all that was required. Compromises kept being made, and by some time in 1968, we had reached a point where I said that the proposed solution was not good enough, and that we should re-think the project.



Honeywell 316 computer + Olivetti Te328 terminal

So I began looking for a totally different kind of solution, based on one of the new mini-computers then coming on the market. I looked at several manufacturers' machines, and decided on the Honeywell 316 mini-computer as the central processor, with four on-line Olivetti Te328 terminals linked to it.



1529 High Road
Whetstone
London, N.20

17th October 1967.

M.S.G.Prince Esq.
Joint Managing Director
Unit Trust Services Ltd.
16 Coleman Street
London E.C.2.

Dear Mr.Prince,

Further to my recent discussions with you, this is to let you know that I have offerred my resignation to Deteco and that I expect this to be accepted and to take effect as from 16th October 1967.

I am, therefore, free to offer my services to Unit Trust Services Ltd. as Computer Consultant as from 16th October 1967 and would suggest the following terms of employment, which are similar to those under which I have been serving at Deteco:

Salary £2700.p.a. plus luncheon vouchers 15/0d. per week; three weeks paid holiday, exclusive of Public Holidays: option of one extra week holiday unpaid; the Company's normal working hours; termination of employment by one month's written notice on either side.

Taking a long term view, in the event of your Company's purchasing its own computer, I would be willing to take charge of its installation and management, and would be willing to act as consultant meanwhile, not only to U.T.S. but also to any of the companies associated with U.T.S.

Regarding salary, I feel that you may find it a little difficult to justify paying me £2700., but I would point out that this is not a high salary for a consultant in the computing industry, especially in the London area; to my certain knowledge a computing specialist employed by a professional Consultancy can earn as much as £4000.

For my part I can visualise sufficient work at U.T.S. to keep me fairly fully occupied until next April; beyond that time I cannot predict with certainty, although I understand that you do have a few other projects to which you may like me to devote my attention. But I am not convinced that you can justify employing me after those projects are completed. At least, I think it is fair to comment that there is a degree of uncertainty regarding my employment in, say, a year's time.

In view of the above considerations, and bearing in mind that if I were instead to join a professional Consultancy now, I would expect to be earning in a year's time not less than £2900. I would like to suggest the following arrangement:

Employment indefinitely by U.T.S. under the terms mentioned above, subject of course to satisfactory service; in July 1968 a review of the situation by both myself and by U.T.S.

Yours sincerely,

David J.Pentecost

agreed
18/1/67

Letter of engagement with Unit Trust Services (from a poor carbon copy)

I was responsible for designing the system and arranging to have the programs written, and I did not want to rely on staff from another company. There was an outstandingly intelligent UTS employee, a former commercial airline pilot, whom I thought could become a good programmer, and we both went on a training course with Honeywell to learn about programming the H316 computer. This computer had been marketed hitherto for use in industry as a process control machine, but I realised that it would be ideal for our commercial purposes, and I persuaded Honeywell so. It took the two of us more than a year to develop an environment to permit on-line terminals to function independently from each other and under the control of the H316. In effect, we had to develop an operating system, as well as writing the application programs.

The H316 was available in several physical configurations, and I chose a 19" rack-mounted system, with a paper tape reader and punch attached.

A brief description of the system appeared in the Financial Times in July 1970:-

The Financial Times Wednesday July 1 1970

The Technical Page

EDITED BY ARTHUR BENNETT AND TED SCHOETERS

COMPUTERS

Low-cost contract system

CONTRACTS detailing the purchase or sale of units from six of the City of London's unit trust management groups will soon be produced entirely by equipment centred in a very small computer, now being developed by Unit Trust Services, an independently operated company providing complete administrative services for unit trusts.

Based upon the diminutive Honeywell H316 computer, the £17,000 system considerably reduces the effort required to complete unit trust bargains by automatically generating the appropriate contract notes ready for posting to the client.

Each day updated prices of the trusts are first fed into the computer to join a file of standard information, including the names and addresses of the trust management companies and their principal agents. When an order for the purchase or sale of units is received, the details are entered into the system through one of four on-line terminals.

The H316 immediately allocates a contract number, calculates the cost of the purchase or value of the sale (together with the amount of commission if applicable), and prints on a standard form inserted in the terminal the complete contract including the name and address of the unit trust company and client.

At the end of each day the system automatically produces summary listings of business—in peak times up to 1,000 contracts a day. Listings are made by ascending contract number within each category of unit trust and include a financial summary of the bargains completed in each category.

A similar article also appeared in Computer Weekly:-

COMPUTER WEEKLY

Number 198 Thursday, 2 July, 1970 Price 1s 6d

PAGE 4

UNIT TRUST DEALINGS PROCESSED ON H316

CONTRACTS dealing with the purchase or sale of units from six of London's unit trust management groups are to be produced entirely by a Honeywell H316-based system now being developed by Unit Trust Services, an independently operated unit trust administration service organisation.

The system automatically generates appropriate contract notes ready for posting to a client and each day up-dates unit trust prices on a file of standard information which includes the name and address of the trust management companies and their principal agents.

When an order for a purchase or sale is received, the relevant details are entered into the system through one of four on-line terminals. The computer then allocates a contract number, calculates the cost of the purchase or value of the sale, together with the amount of commission, and prints out the completed contract including the name and address of the unit trust company and client.

The H316, believed to be the first of its type to be used for commercial applications in the UK, was delivered last month to UTS's Coleman Street, London, EC2, offices and includes 8,000 words of memory, high speed paper tape reader and punch, and four on-line Olivetti TE 328 terminals, each with 10 chps paper tape input/output equipment.

Scottish support

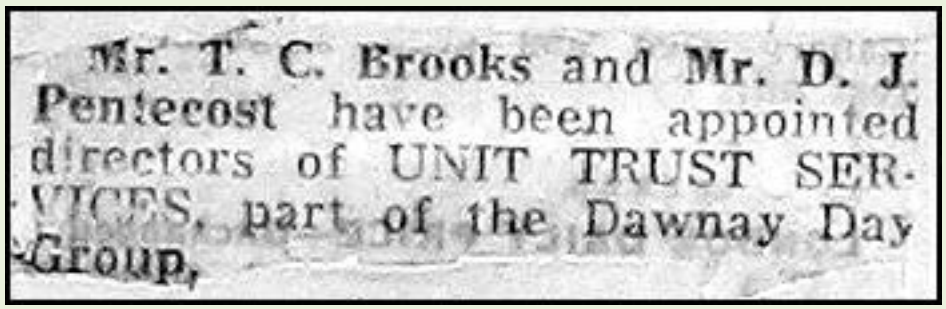
A NEW company called Systems Implementation Ltd has been formed with offices in Station Square, Inverness, to provide systems and programming support to computer users throughout the country.

The system was the first of its kind in the U.K. It was designed to be as failure proof as possible, and it functioned for an unprecedented ten years, with only four days of down time during that entire period.

The H316 system and the computer system in operation at the bureau in Cockfosters were being used for all the unit trust management company clients of UTS. The unit trusts which had been set up by Prince, Simon & Co were all brought under the

management of a new company which was formed, called Target Trust Managers Ltd, part of a group called Target Trust Group. Target was taken over by Dawnay Day, a financial services group in May 1972, but continued trading under the Target name.

It was in the summer of 1972 that I, and my colleague Terry Brooks (one of the accountants), were appointed as directors of UTS:



Mr. T. C. Brooks and Mr. D. J. Pentecost have been appointed directors of UNIT TRUST SERVICES, part of the Dawnay Day Group.

From the Financial Times

I received a letter of congratulations from Brian Brown, general manager of one of our clients, the TSB group:

TSB

General Manager
B.M.J. Brown A.S.I.

T.S.B. UNIT TRUST MANAGERS LIMITED

P.O. Box 41, 49/53 Surrey Row, Blackfriars, London SE1 OBY
Tel. 01-928 3551

BMJB/PH

4th September 1972

D. Pentecost Esq.,
Unit Trust Services Ltd.,
16 Coleman Street,
London EC2.

Dear David,

On returning from my holiday I was pleased to note that you have been appointed a Director of Unit Trust Services Limited.

May I offer you my congratulations on this appointment and wish you all success for the future.

Yours sincerely,

Brian

B.M.J. Brown,
General Manager.

Directors P.F. KEENS OBE FCA Chairman A. ARCHIBALD OBE L. BARBER MBE J.D. CAMPBELL MBE SIR ATHELSTAN CARÜE CBE BA

There came a time when Bank X was being left behind, in that it was the only one of the big four banks which did not have its own unit trusts; it needed to set up those unit trusts in a hurry. But the bank did not have the expertise or the computer systems to do so quickly. UTS was approached (I think around 1973) in strict confidence by Bank X, to discuss whether there could be a way for UTS to administer the unit trusts which the bank wished to launch, without it becoming generally known that the bank was not doing its own unit trust administration work.

Clearly the work could not be undertaken by UTS directly. Bank X accepted that some UTS staff could do the work, but under the umbrella of a new company which would be set up. I think it was I who suggested that the name of the new company be Unit Trust Administration Ltd. The function of the new company would be to undertake work only for Bank X. Terry Brooks and I were appointed directors of Unit Trust Administration. A separate London telephone number was arranged with the General Post Office, (which then ran the telephone service subsequently operated by British Telecom) for members of the public to use to make enquiries. Some of our staff acted as Bank X staff, and used Bank X stationery for correspondence.

So over the next few years, the amount of unit trust work which we did expanded considerably. The Target group had also formed a building society and a life assurance company, which were located in the City but not at 16 Coleman Street, because of lack of space.

The time came to bring Target Group's operations, including the work done by UTS and Unit Trust Administration under one roof. The Target directors decided to look for a plot of land outside London, and commission the construction of a building to house everyone, apart from a few marketing staff who needed to remain in the City. There was a long discussion about where the new building should be located, and the most important factor was not to lose critically important staff, and to make it possible for as many clerical staff as possible to move to the new location.

Enquiries centred on Aylesbury in Buckinghamshire, partly because of where three key staff (two senior accountants and myself) lived. We were in Watford, Thame and Leighton Buzzard, all of which towns were within easy reach of Aylesbury. Discussions took place with the Aylesbury local authority, regarding providing homes locally for as many clerical staff as possible who would be willing to move house.

In due course, a new building called Target House, with good parking facilities, was constructed in Gatehouse Road in Aylesbury. A photo of the building is on the next page; (it is no longer occupied by Target Group). On the ground floor on the road side of the building was a new air conditioned computer room. A large Univac computer was chosen to do the work for the unit trust company and for the life assurance company, and I helped to recruit some new computer operations staff.

The move from London to Aylesbury in due course took place, but not without difficulties with clerical staffing for a period of about six months. Terry Brooks and I were appointed joint general managers of UTS; Terry was responsible for the accounts department, and I was responsible for all the other departments.

I think it was late in 1975 when we were hit with a devastating blow. A substantial part of our income came from business with Bank X, and the bank had decided that it was then in a position to take over the administration of its own unit trusts. It may be that they had had a long term plan to do this, and if so, we were not aware of it.

Target House, Gatehouse Road, Aylesbury

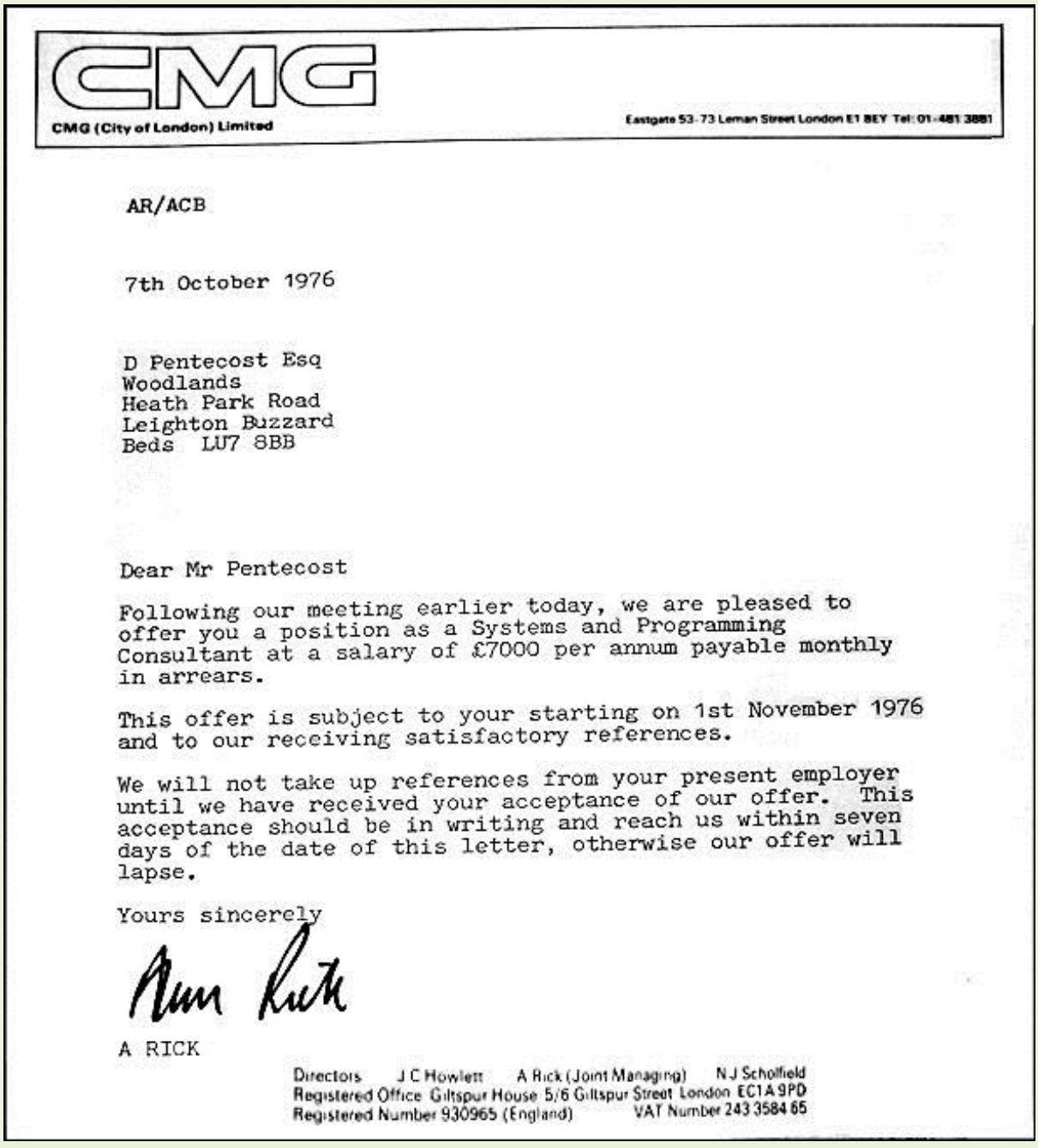
After the handover process was completed, we had to reduce staff numbers. I found it hard to tell people that they were being made redundant. In 1976, cost cutting had to continue, and Michael Prince told me in April 1976 that the group could no longer afford to employ two general managers; on 3rd May 1976 I was formally made redundant, as was a fellow UTS director. It was both a shock and a relief; a relief, because I never enjoyed managing people, apart from the technical computing aspects. I was essentially a technician – a computing specialist.

I resigned my directorships in April 1976, but remained an employee, working on my own, particularly on some specialist legal issues concerning trust deeds, as they related to the administration of the unit trusts. It was agreed that I could continue as an employee until I found a new job. I kept my salary of £8,750 until my leaving date, (which was eventually agreed as 31st October 1976), and I was allowed to keep my company car (a small fibre-glass Reliant Kitten) for an agreed fee. Because of the petrol price crisis, I had a few years earlier changed my company car from the huge gas-guzzling metallic green Ford Granada estate car, to the very economic Reliant, which did about 50 miles to the gallon, saving me a lot of money.

I decided to go back into what I knew best – computing – and I registered with some computer employment agencies. Eventually I was put in contact with CMG, founded in 1964, a well-known international software house and computer bureau, and at one time included in the FTSE 100 Index. One of its offices was near Aldgate East underground station in London. It meant a salary reduction, but I expected that.

Chapter 7: CMG (CITY OF LONDON) LIMITED

On making contact with CMG, I found to my surprise, that one of the joint managing directors was Alan Rick; we knew each other, although not well. He had worked, as I had, at ISIS in Lime Street. That must have helped in my being offered a job as a systems and programming consultant. I was back doing programming after a gap of several years, and I was very pleased, although I had to refresh myself in programming with the COBOL language.



CMG

CMG (City of London) Limited

Eastgate 53-73 Leman Street London E1 8EY Tel: 01-481 3881

AR/ACB

7th October 1976

D Pentecost Esq
Woodlands
Heath Park Road
Leighton Buzzard
Beds LU7 8BB

Dear Mr Pentecost

Following our meeting earlier today, we are pleased to offer you a position as a Systems and Programming Consultant at a salary of £7000 per annum payable monthly in arrears.

This offer is subject to your starting on 1st November 1976 and to our receiving satisfactory references.

We will not take up references from your present employer until we have received your acceptance of our offer. This acceptance should be in writing and reach us within seven days of the date of this letter, otherwise our offer will lapse.

Yours sincerely

A RICK

Directors J C Howlett A Rick (Joint Managing) N J Schofield
Registered Office Giltspur House 5/6 Giltspur Street London EC1A 9PD
Registered Number 930965 (England) VAT Number 243 3584 65

I soon discovered that everyone in the company was working flat out, to complete projects to tight deadlines. One had to offer a good explanation if one was more than five minutes late for work. I found it necessary to take programming work home with me, not only sometimes to continue at home, but almost always working on the train between Euston and Leighton Buzzard. The journey to work from Euston was not easy: a walk to

Euston Road station, to take an Underground train to Aldgate East, and then a good ten minute walk to the Leman Street office. I wanted to show here a photo of the building, but the whole site has been redeveloped. I remember one terrible day when the air was so filthy with smog, and visibility was so poor, that an asthma attack almost overcame me. I had to stop walking, to catch my breath for a few minutes, move a few yards, stop again, and so on until reaching the office. If there had been mobile phones in those days, I would have summoned an ambulance.

CMG decided at one point to develop a payroll and related system, called Payfact, to offer services to companies at its computer bureau. I was allocated one of the programs in the suite, and as it turned out, it became the largest program in the system; it required over 3,500 lines of COBOL code. But all went well, and Payfact was very successful. Here is a quote from the CMG entry in Wikipedia, which can be seen at https://en.wikipedia.org/wiki/CMG_(company)

"Though the most mission critical business process for CMG was always selling consulting services, the company also had a large internal IT department to service the company's infrastructure and manage services for large customer applications. One of the most popular applications which it developed and sold for decades, was PAYFACT, a payroll and HR reporting system that gained widespread use in the Netherlands in the 1990s."

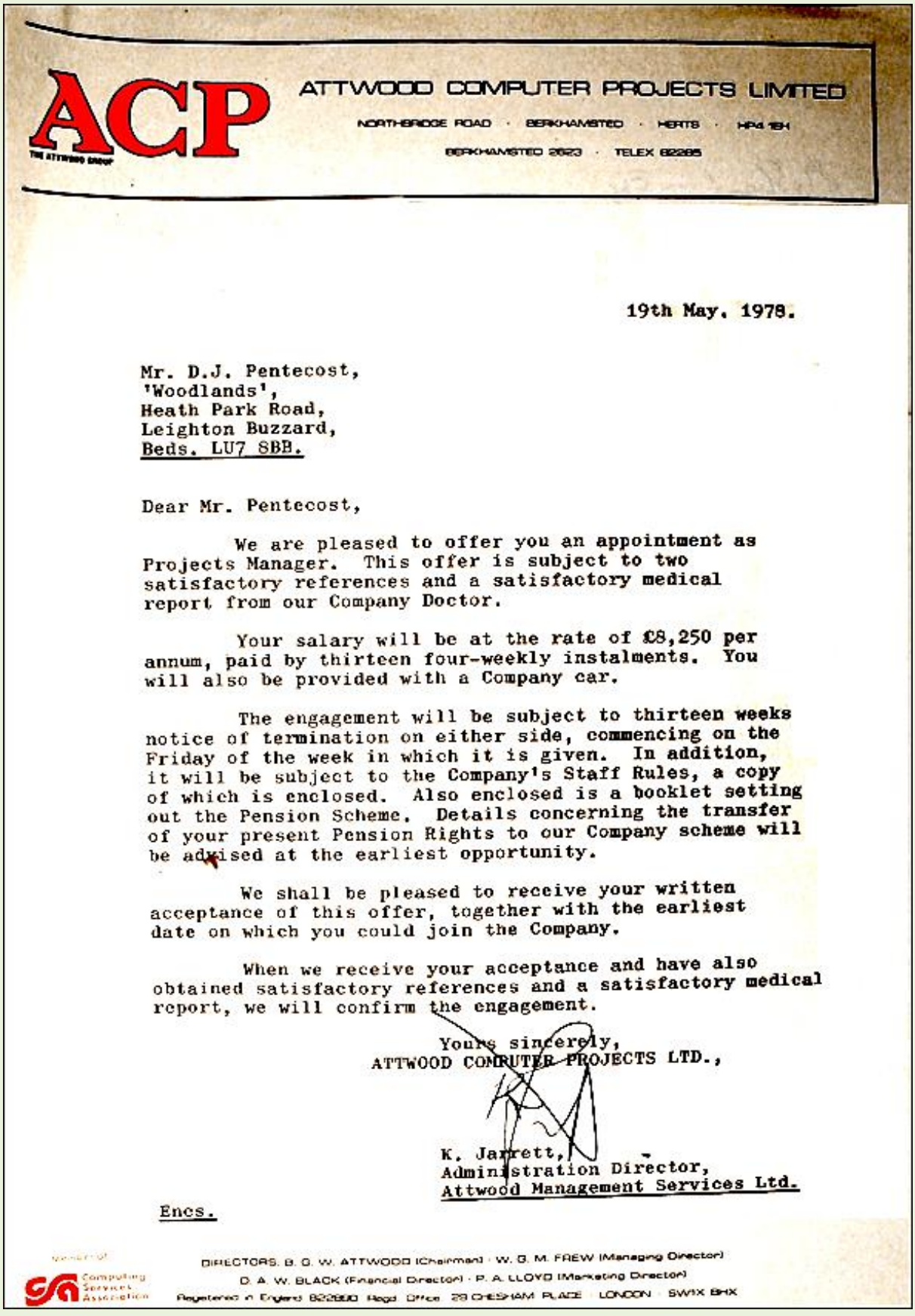
There came a time, early in 1978, when business was hard to get; few of us had any work to do. So we were all ordered to become salesmen for the company. We had to use our own initiative to contact companies to elicit new business; it meant cold calling on the telephone. I really hated it, because I am no salesman. Yet the odd thing was, that I seemed to be more successful at getting appointments to visit and talk to prospective customers than anyone else.

I decided that I had to leave; this was not a working atmosphere which I could tolerate for much longer. And I missed the technical seniority which I had previously had: I was just one of a dozen or so programmers in the office, reporting to the general manager. Having experienced working near my Leighton Buzzard home, when I was employed in Aylesbury, I decided to find and register with some local recruitment agencies, to see if I could avoid the long and increasingly expensive commute into London.

That journey over the years since the late 1960s varied enormously in acceptability. In the early days, the train was almost empty when it arrived at Leighton Buzzard station on its journey to London, so there was no problem getting a seat. There were at most, six of us in the carriage at Leighton Buzzard. As Leighton Buzzard, and places further north expanded, especially Milton Keynes, commuting steadily grew over the coming years, and the journey became more and more uncomfortable, as the train became packed. One had to learn where to stand on the platform in order to get in, and sometimes almost battle to get a seat. In some harsh winters, the journey was appalling; the trains had no sliding doors, but many small conventional swing doors, which let in a howling gale in bad weather. And often the heating system was not working. In some years, delays were extremely common.

One recruitment agency, which I found in Berkhamsted, was called Castle Recruitment. They soon found a possible opening for me, in Berkhamsted. The managers at CMG were somewhat astonished that I had found a job outside London with an increased salary, and use of a company car, thus saving me huge amounts in train fares.

Chapter 8: ATTWOOD COMPUTER PROJECTS LIMITED



ACP
THE ATTWOOD GROUP

ATTWOOD COMPUTER PROJECTS LIMITED
NORTHBRIDGE ROAD · BERKHAMSTED · HERTS · HP4 1EH
BERKHAMSTED 2623 · TELEX 82285

19th May, 1978.

Mr. D.J. Pentecost,
'Woodlands',
Heath Park Road,
Leighton Buzzard,
Beds. LU7 8BB.

Dear Mr. Pentecost,

We are pleased to offer you an appointment as Projects Manager. This offer is subject to two satisfactory references and a satisfactory medical report from our Company Doctor.

Your salary will be at the rate of £8,250 per annum, paid by thirteen four-weekly instalments. You will also be provided with a Company car.

The engagement will be subject to thirteen weeks notice of termination on either side, commencing on the Friday of the week in which it is given. In addition, it will be subject to the Company's Staff Rules, a copy of which is enclosed. Also enclosed is a booklet setting out the Pension Scheme. Details concerning the transfer of your present Pension Rights to our Company scheme will be advised at the earliest opportunity.

We shall be pleased to receive your written acceptance of this offer, together with the earliest date on which you could join the Company.

When we receive your acceptance and have also obtained satisfactory references and a satisfactory medical report, we will confirm the engagement.

Yours sincerely,
ATTWOOD COMPUTER PROJECTS LTD.,

K. Jarrett,
Administration Director,
Attwood Management Services Ltd.

Encs.

Member of Computing Services Association

DIRECTORS: B. G. W. ATTWOOD (Chairman) · W. G. M. FREW (Managing Director)
D. A. W. BLACK (Financial Director) · P. A. LLOYD (Marketing Director)
Registered in England 822880 Regd. Office 29 CHESHAM PLACE · LONDON · SW1X 8HX

I had come across a company called Attwood Statistics Ltd back in 1962 when I worked at Elliotts in Borehamwood. In the late 1950s, there was a need by television companies

to measure the audiences for particular broadcast programmes, especially after the setting up of ITV as competition for the BBC in 1955.

Attwood Statistics arranged with a representative selection of home owners with televisions, for them to record which television programmes they watched each day, by use of a device invented by Attwood, called a Tam Meter. There must have been many hundreds of such meters – possibly a few thousand. Every so often, perhaps daily, information was collected from these meters (I do not know the mechanism for doing this) and was delivered to Elliott Brothers' computer bureau. The data were prepared on a teleprinter, producing paper tape, which was processed by an Elliott 405 computer and analysed. The resulting output was a table of popularity of TV programmes, known nationally as the TAM Ratings, and they were published in most daily newspapers.

So it was a surprise to join Attwood Computer Projects (ACP), a company run by the same man, Bedford Attwood, who had set up Attwood Statistics. By the time I joined ACP, TAM ratings had been taken over and run by a company called AGB (Audits of Great Britain).

The drive from Leighton Buzzard to Berkhamsted each day was a delightful one, through country lanes, and it was such a pleasant change from the train journey to London.

I was recruited to head up a small team running a project for a company in Chesham, called Agricultural Central Trading (ACT). ACT's business was to source farm products and sell them to farmers all over the country. I have a recollection that ACT had been created by the National Farmers' Union. Bedford Attwood was the chairman of both ACP and of ACT, and therein lay a problem for him – a conflict of interest.

He had initiated the setting up of a computer system for ACT in their Chesham office. The computer was a Modular One, made by Computer Technology Ltd (CTL) of Hemel Hempstead. (CTL had been set up by Iann Barron, having designed the 803 computer for Elliotts, and it was he who later at INMOS conceived the transputer, which was developed there). But there was a problem with the ACT computer system, and it was to solve this problem that I had been recruited, I later learned. The computer system ran much too slowly. I had to head a small team to solve the problem. I was told that work had already been done to re-write some of the program code using a different programming language, called Coral 66, but that more code needed to be re-written, to replace the comparatively inefficient COBOL-generated code, which had been used for nearly all the programs. This was undertaken with a struggle, but the improvement was negligible. We then had talks with CTL about the problem, and we concluded that the real reason for slowness was probably that the computer had insufficient fast memory for the programs to operate in, and that buying more memory could solve the problem.

Bedford Attwood was embarrassed that the system at ACT was not as efficient as it should be. He would be more embarrassed if he had to tell ACT that ACP had recommended a computer too small, and that ACT must spend more money on it.

I asked for a meeting with him, and told him that I believed that more fiddling with the computer programs would be a waste of time and money, and that the computer needed

more memory. This would, of course, incur an expense, but one did not have to commit to spend the money immediately; we could ask CTL to install extra memory on trial, to see if that would solve the problem; if it did not, the additional memory could be removed, but if the problem were solved, then expenditure would be necessary: whether by ACT or ACP was Bedford Attwood's problem.

The outcome was that more memory was installed, and the system did function faster. I do not know who paid for the additional memory.

There had been another problem which occurred on most days: the system would crash, the office business would come to a halt, and the computer would need to be restarted. We noticed that the system crash often occurred at about 11 a.m., although also at some times in mid-afternoon. We spent some time wondering what happened at about that time of day on the computer to cause a crash; none of the computer programs did anything determined by the time of day. But the crash did not occur exactly at 11 o'clock – only approximately.

What was happening in the office at that time? Well, coffee was delivered around the office, from a coffee trolley, but that seemed ludicrous as a cause. One day, not really believing what we were doing, we watched the coffee trolley. Sure enough, at one position of the trolley, the computer crashed. The answer was that under the carpet was a cable, and a wheel of the heavy trolley had compressed the cable. So the problem was solved!

Early in 1980, we did not have much to do in the office, and I feared that ACP's business was going to be closed down. So I registered myself once more with a few well-known computer recruitment agencies. One of them was John Goldsmith, one of the top national agencies, and I think it was by him that I was contacted one day in April.

The agency had been retained by a very large law firm, to recruit a business systems manager. He described the position to me and asked if he might forward my CV to the firm. I don't think he revealed to me at the time which firm it was, but it was in London. He said that the initial salary was good, but that it would rocket up, in the years to come.

Chapter 9: COWARD CHANCE (later Clifford Chance)

The firm was Coward Chance, which occupied most of one of the tower blocks along London Wall; it was in fact in Royex House in Aldermanbury Square. I was interested, because one of my ex-colleagues, John Porter (with whom I had worked at ISIS on the B&C payroll project), had done some work for a small law firm in Kingsway, London. I had met John occasionally, and I was fascinated by the work he had done there. So the opportunity to do something similar, but on a much larger scale, was most appealing.

5 Aldermanbury Square, London (Google photo)
(This is a rebuilt version of Royex House; it looks very similar to me)

In due course I was interviewed by Michael Mathews, one of the partners, who eventually was to become President of the Law Society. He asked me if I was a relative of Wendy Pentecost, who formerly worked there as a secretary. I was not aware of it at the time, but I later discovered that she was one of my second cousins. I was also interviewed by the partnership manager, to whom I would report. The latter, who was I think fairly new

to the business, on engaging me told me “to live well here, because this is a rich firm!” (He left shortly afterwards through illness, and was replaced by a Scotsman).

I was taken on as business systems manager, as from 2nd June 1980, at a starting salary of £13,750, an increase of more than 50% over my previous salary at ACP. This was to be the first time that I would work for a big organisation, since leaving Elliotts in 1962.

I was told by the partnership manager, when I started work, that my first problem would be lack of resources, i.e. staff. I was shown the small computer room, which contained a Nixdorf mini-computer with four on-line terminals, and a few physically large removable disc platter units. Four non-technical staff were running the system, preparing and inputting data, with one of them supervising the other three, and responsible for operating the computer. It was all under the guidance of a remote software house, called Norwel, based in Manchester, which had supervised installation of the computer, developed the software, and trained the four operators.

A basic function of the system was to input the time-sheets written by each of the firm’s London-based lawyers, or dictated by a lawyer and written up by a secretary, to record each element of time (and hence its cost) against the matters worked on by the lawyers. So the cost of a lawyer’s time spent working on a matter for a client could be established at any point in time, in order to assist billing the client.

I learned from the computer supervisor/operator that there were many improvements which she thought needed to be made to the programs. But it was a practical problem to achieve these changes, because it would be necessary to call down staff from Manchester. I needed to take steps so that we would not be so dependent on Norwel.

One of the programmers who joined ACP shortly before I did, was Trevor Hopkinson, who also as it happens, lived in Leighton Buzzard. When I left ACP, shortly afterwards he also left, and joined Target Life Assurance, part of the Target Group in Aylesbury, working in the same building which I had left in 1976. I needed to recruit someone to assist me at Coward Chance, and I asked Trevor, a top class programmer, to join me, which he did, in July 1982.

Until 1982, I took over making improvements to the Nixdorf programs, which proved fairly easy to do, sending each proposed program change to Norwel in Manchester for approval before implementation. Thereafter, Trevor and I both worked on maintaining the system. As with nearly all computer systems, we encountered problems from time to time, especially when running the end of month accounting programs. I remember a few occasions when we both worked through the night in order to resolve an obscure program fault.

At the same time as we were keeping the Nixdorf system running, and learning more about the business practices of the firm, I began to work on an idea for a radical set of changes, which would eventually involve replacing the Nixdorf computer. It would take a long time to specify the ideas, and seek approval from the partnership for the changes. More technical staff would be needed: system design and programming staff, and

computer operators, far more knowledgeable and sophisticated than the four staff then employed.

Before I describe briefly what I had in mind, I need to explain how some aspects of the practice functioned. There were about 200 lawyers in the London office, without any computing equipment of their own. In general, each lawyer had a secretary, or in a minority of cases shared a secretary with another lawyer, and each secretary used an electric typewriter.

My vision was a large central computer to take over the time-sheet processing and accounting functions of the Nixdorf computer, and eventually to perform other tasks not yet computerised; every secretary would have an intelligent terminal replacing the typewriter, linked to the central computer. These terminals would permit input of details of clients and time-sheets to the computer, and allow enquiries on the data to be made; crucially, each terminal would also function as a stand-alone word processor, working as such, whether or not the central computer was on-line; documents would be stored on 5¼" floppy discs. Each word processor would be linked to a local laser printer, each printer normally being shared between two or three secretaries. Producing documents on time is the life-blood of every law firm, and this function could not depend on a central computer which might fail, or might not always be switched on.

Lawyers could have a dumb terminal, if they wished, linked to the central computer for making enquiries, and for entering data if they wanted to do so, rather than devolving that task to a secretary.

I was told by a few partners that before making any major changes to the firm's systems, I should visit some of the big law firms in New York and elsewhere in the USA, with whom Coward Chance had close contacts, to see what systems they had developed, in order to gain ideas. I did so, accompanied by one of the partners, and was astonished at what I found. It had been expected that the Americans would be ahead of us, and in a sense they were, because the systems they had, had been developed many years before, and most were largely based on storing and processing millions of punched card records. They *had* been ahead of us, years before, but their technology was now very much out of date. We could learn almost nothing from them. What I had in mind was far more advanced, being based on current technology.

I searched the international computer technology market, examining equipment available from the major manufacturers, and was surprised at what I found. There was only one such manufacturer which could meet our technical requirements, and that was Burroughs. Before the advent of the PC, they had specialised word processors, called OFISwriters, which could be linked to a central computer for entering data and making enquiries. It was surprising and disappointing that IBM did not have a comparable offering at the time.

A contract was eventually drawn up and signed with Burroughs for supply of the hardware and some of the software. The mainframe computer contracted for was a B5985, but on the advice of Burroughs themselves, when they later believed that the computer would not be powerful enough to handle the firm's workload, the computer was

upgraded, I think to a model A10. We engaged Burroughs staff, and a software house to assist with the design and programming of the system. I also recruited three operations staff and two system designers and programmers as employees of Coward Chance, reporting to me.

One of the first stages of the project was to install the OFISwriters, working only as stand-alone word processors, whilst the systems for the central computer were being developed. Initially a few secretaries were chosen and redeployed to form a small word processing training team, to teach all the secretaries how to use the OFISwriters, with WordPerfect as the word processing software. Courses were arranged and implemented over a period of several months, until every secretary was using an OFISwriter.

By 1985 the computer programs had been written and tested on the Burroughs computer, and the OFISwriters had been networked to the Burroughs mainframe computer. A small team of clerical staff was provided with OFISwriters for a few weeks, to undertake the data entry tasks which had previously been carried out by the Nixdorf operators. They took over time-sheet entry for a few weeks, while the secretaries were taught to undertake this task.

As well as the major functions of the system mentioned above (time-sheet processing, billing, accounting, word processing and maintenance of a database of client and matter details), there were a few subsidiary systems developed, but also accessible from the OFISwriters and enquiry terminals.

One of these systems was a program which I wrote, to enable calculation of interest due on deposits made, particularly on behalf of clients. The system maintained a table of base rates of the major UK banks and of some major international bank base rates. The enquirer would select the base rate to be applied, enter the initial sum of money, the start and ending dates of the investment, any percentage increment to be applied above the base rate, whether a simple or compound calculation was needed, and whether just a total of interest accrued or a complete analysis of the calculation was required to be displayed or printed.

In February 1986, the management of Burroughs was so impressed with the design and functionality of the entire system, that they invited us to prepare and give a presentation to management staff at their offices in the USA. We prepared a slideshow illustrating the system with diagrams and screenshots. Burroughs flew our partnership manager Alastair Crawford, me and our word processing supervisor, Sandra Soundy to their offices in Dearborn, Michigan, and to some of their manufacturing plants on the west coast in California, driving us down the west coast road to Los Angeles. (It was very frustrating to drive past the J. Paul Getty Museum but not have time to stop to see the exhibits). Then we visited an office in Atlanta and another in Miami. We had time to fit in a visit to Disneyland, and I took a trip parasailing off Miami beach from a speed boat; it was exciting, and my only worry was that should there be a mishap, I was (and still am) a non-swimmer.

In July 1986 I was asked to visit Coward Chance's Hong Kong office, where a proposal had been received from Wang, for a word processing system. My wife Kay came with

me, and we spent about ten days there, using up some of my annual holiday allowance. I reviewed the word processing proposal, and considered an alternative system offered by Burroughs. Wang won the contract, but they had to supply the better laser printers which I had recommended. (There was time for me and Kay to join a 1-day tour party to mainland China; I remember that we were quite closely escorted, and were each allocated an identifying number, written on a sticker which we had to wear on our coats).

(In September 1986, the computer industry's major surprise news was that Burroughs had bought out the Sperry Corporation, and the new company was named Unisys, which still operates today - 2023).

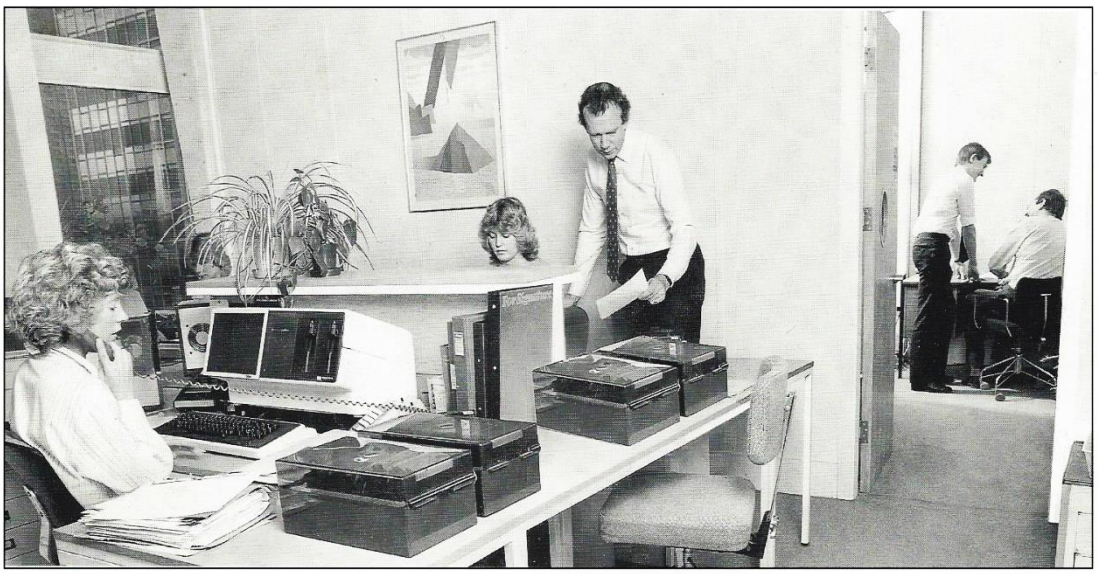
On the next few pages is the brochure which, with help from Burroughs, we produced for the staff of the firm, giving an overall view of the scope of the London system, which we called the Office Automation System.

The electronic mail system is worthy of a special note. Burroughs suggested that part of the software which they were to deliver should include the ability for staff to communicate with each other via an internal email system. There was considerable scepticism from many lawyers about how worthwhile this would be; nevertheless, it was agreed that the software would be developed. At that time there was no general Internet in existence, and it would be a decade before world-wide electronic mail became possible. Today we are all familiar with email, but in 1985 it was a new concept, and a quite brave decision to develop the internal email system.

As well as being in overall charge of the development of the Office Automation System, I specified and did the programming for the client billing part of the system, which was a major undertaking, bringing together the value of time worked by the lawyers on the one hand, and on the other, the costs of disbursements incurred on behalf of the client, in order to print a draft bill.

In 1986 the Office Automation System was in operation, and it was performing its designed functions. Our application software worked very well, but there were some problems with the underlying Burroughs operating system software. The system would sometimes crash for a while; however, Burroughs had very good recovery software which they were proud of, saying, probably correctly, that it was the best in the world; but it needed to be! The crashes were annoying, but not disastrous, and did not have serious effects on the working of the system.

Office Automation System



The Office Automation System (or OAS for short) is a series of computer programs that help you to create, review and distribute information around the offices of Coward Chance.

WHAT DOES OAS DO?

OAS runs on the Burroughs B5900 mainframe computer in the Royex House 17th floor data centre. You can communicate with it by using one of the Burroughs OFISwriter word processors or terminals.

Using OAS, you can:

- perform all the standard OFISwriter word processing tasks such as creating, storing, amending and printing documents
- transfer documents between OFISwriters. The documents may then be read, edited and transferred back
- produce documents on the remote laser printer
- send telex/teletex messages
- send and receive electronic mail
- keep details of clients and matters
- record time and copying charges
- bill clients
- maintain the firm's accounting records.

The system may be enhanced to include other facilities in due course.

You can also be sure that your work is secure, because no one can gain access to it without authorisation.

HOW DO I USE IT?

OAS is simple to learn and use. It consists of a series of easily accessible menu screens, listing options from which you select the one that you require.

When you are entering information into the computer, "prompts" are displayed on the screen to assist you.

When one activity is finished, you can return to the menu from which the task was started, and select another option. The system also allows direct access to any activity simply by typing in the name of the one you want.

Help

A comprehensive series of screens (known as "help" screens) can be called up at any time to assist you in using the system. In addition, the User Guide (which is available as a separate document) gives step-by-step instructions on operation of all parts of the system.

Operation and Management

THE MAIN MENU

When you start using OAS, the main menu is displayed. From this menu you can begin any of the OAS activities described.

The inquiry facilities will be of particular interest to those seeking up-to-the-minute information from the data base on any of the activities.

CONTROL

OAS is managed for you by the System Administrator who has responsibility for:

- specifying which terminals and OFISwriters can use the system and where they are located
- instructing the computer about who is permitted to use each part of the system
- organising use of computer time for maximum efficiency
- monitoring usage and reliability and organising maintenance of the computer.

No one can use the system without a usercode and password, and the System Administrator assists you in setting these up; however, even he will not know what your password is.

The **Personal administration** menu allows you to change your password as necessary.

Locking your terminal

OAS allows you to lock your terminal electronically to prevent others from altering work you have had to leave temporarily.

You could, for example, attend a meeting, leaving some work unfinished on the screen.

Interrupting an activity

You may also temporarily interrupt your work (other than word processing) to use another OAS function.

This is useful if you receive notification on your screen telling you that an urgent message has just arrived in your electronic mail-box. You can stop what you are doing to read (and, if appropriate, print) the message.

Telex, Document Production and Transfer...

TELEX

You may use the **Telex** menu to send a telex or teletex message to one or more destinations on the public networks.

Telex messages can be created at and sent from an OFISwriter. A legal document prepared on an OFISwriter can also be transmitted as a telex message, although you may wish to add a preface to the document before transmission.

Short telex messages can also be created at and sent from a terminal.

You can monitor the progress of recently sent messages and cancel the transmission of any message up to the moment when it is actually sent into the public network.

You can also create and maintain a list of abbreviations for each frequently used telex number or groups of numbers. These abbreviations, instead of the full number and answerback code, can be used to send messages.

Incoming messages are monitored in the Telex Room, and at your request can be transferred to a secretary's OFISwriter disk.

DOCUMENT PRODUCTION

Local word processing

Each secretary has a Burroughs OFISwriter, and the preparation of all documents and correspondence is carried out at these work stations. The printing of short documents is usually done on the local printer linked directly to the word processor. A special facility for the fast printing of long documents is described below.

Document printing

Using the Coward Chance laser printer you can quickly print high quality documents of any length. OAS:

- copies your document from an OFISwriter floppy disk
- stores it on the B5900 mainframe computer until the laser printer is ready
- prints the document complete with the page numbering which you require
- indicates how long it will take your document to print, and informs you if the laser printer stops working.

Document delivery

For each document printed, the document header sheet contains:

- your name and location
- the name and location of the person within the office to whom it is to be delivered
- the name and location of the author.

Using this information the document will be delivered without any further intervention from you.

DOCUMENT TRANSFER

Any document that has been produced on an OFISwriter can be transferred to other OFISwriter users for review and editing.

OAS will:

- copy your document from an OFISwriter floppy disk
- store it on the B5900 mainframe computer
- inform the person you are sending it to that there is a document waiting to be transferred
- transfer it to that OFISwriter user when they are ready to receive it on a floppy disk.

Electronic Mail...

ELECTRONIC MAIL

The OAS electronic mail-box directory creates an effective and quick means of dealing with internal messages.

Everyone with a usercode can send or receive messages using an OFISwriter or terminal.

Electronic mail means that you can:

- leave a message to await the return of someone whom you have been unable to contact by telephone
- send a message to another user without the possible disadvantages (e.g. delay, loss) of conventional methods
- rapidly send circulars to all users or to selected groups of users.

Electronic mail allows you to send messages:

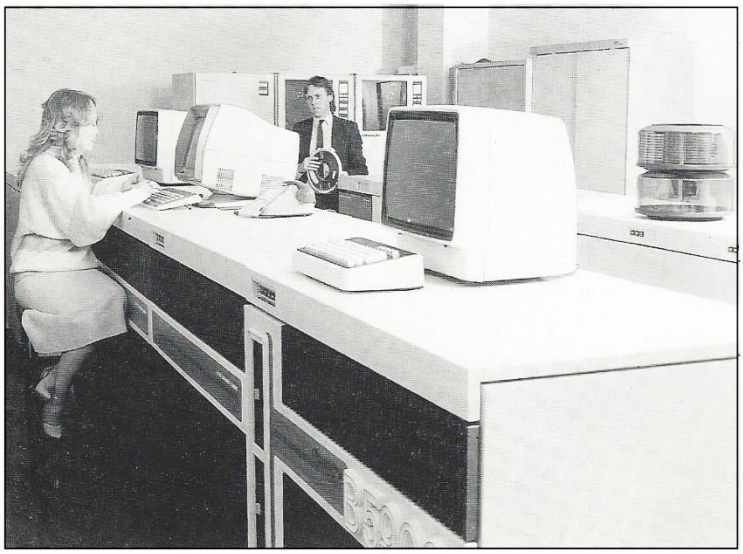
- person to person
- to a group of users on a distribution list – you can be sure that each one will receive the message.

Electronic mail allows you to:

- check your own mail-box and read messages in it
- send messages of whatever length you require
- leave a message incomplete and finish it later
- check whether messages you have sent out have been seen.

You will be able to review your mail-box, create replies to correspondence as necessary and monitor the progress of messages sent out.

You can also print messages on the laser printer or transfer them to an OFISwriter for word processing and manual distribution.



PERSONAL ADMINISTRATION

Using OAS **Personal administration** you can also:

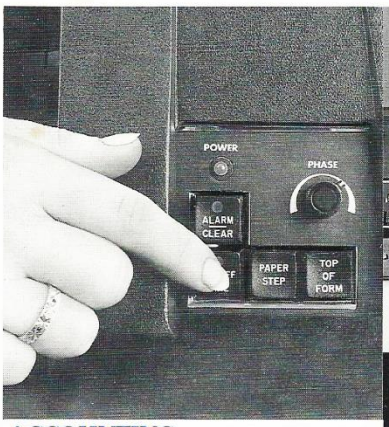
- re-route your electronic mail to another interested party
- authorise access to your mail-box in your absence. This is useful if you wish your secretary to read your mail, or if you are ill or on holiday.

DISTRIBUTION LISTS

Using OAS **Distribution lists** you can:

- send electronic mail to a list of users, all of whom can be accessed by a single code word
- alter your distribution lists at any time to suit your requirements.

...Accounting and a Day's Work



ACCOUNTING

The **Accounting** activities of OAS will:

- keep details of clients and matters
- record time and copy charges
- bill clients
- maintain the firm's accounting records
- provide management information.

Not everyone will use all of these. For example, only people in the Accounts Department will maintain the firm's accounting records.

Using **Clients and matters** you can create, amend and inquire about information on clients and matters, and open, close, re-open or inquire about files.

You can print file labels, which the system will create and update every time a file description is changed.

Time and copy charges allows you to:

- record time-sheets daily
- amend time-sheets
- inquire about time records
- record photo-copying charges.

Billing allows the following steps to be carried out in billing a client:

- drafting and re-drafting of bills
- production of on-account bills
- settlement and delivery of bills
- creation of bill summaries.

THE FIRM'S ACCOUNTS

Certain members of the Accounts Department can perform the following tasks:

- record disbursements
- keep details of the firm's suppliers
- keep account of client funds
- keep account of office funds
- record the delivery and payment of bills
- record petty cash transactions.

A DAY'S WORK

At the end of a day's work on an OFISwriter you might have carried out the following tasks using the Office Automation System.

- Signed on by using your usercode and password
- Re-routed your electronic mail back from someone else to your mail-box, using **Personal administration**
- using **Electronic mail,**
  - checked your electronic mail-box and read the new messages, removing from the box those no longer needed, and printing those for which a hard copy is required
  - sent replies to these messages
- Entered or checked details concerning particular clients or matters
- Keyed in a time-sheet
- Produced a draft bill
- Created and amended documents, using your OFISwriter as a word processor, by using **Local word processing**
- Sent a long document to the laser printer for fast printing
- Locked your OFISwriter while you went to lunch
- Created a telex message as a document on your OFISwriter, by using **Local word processing**
- Sent the telex into the public network directly from your OFISwriter
- Used **Document transfer** to transfer a document to another user
- Signed off the system.

I. 85

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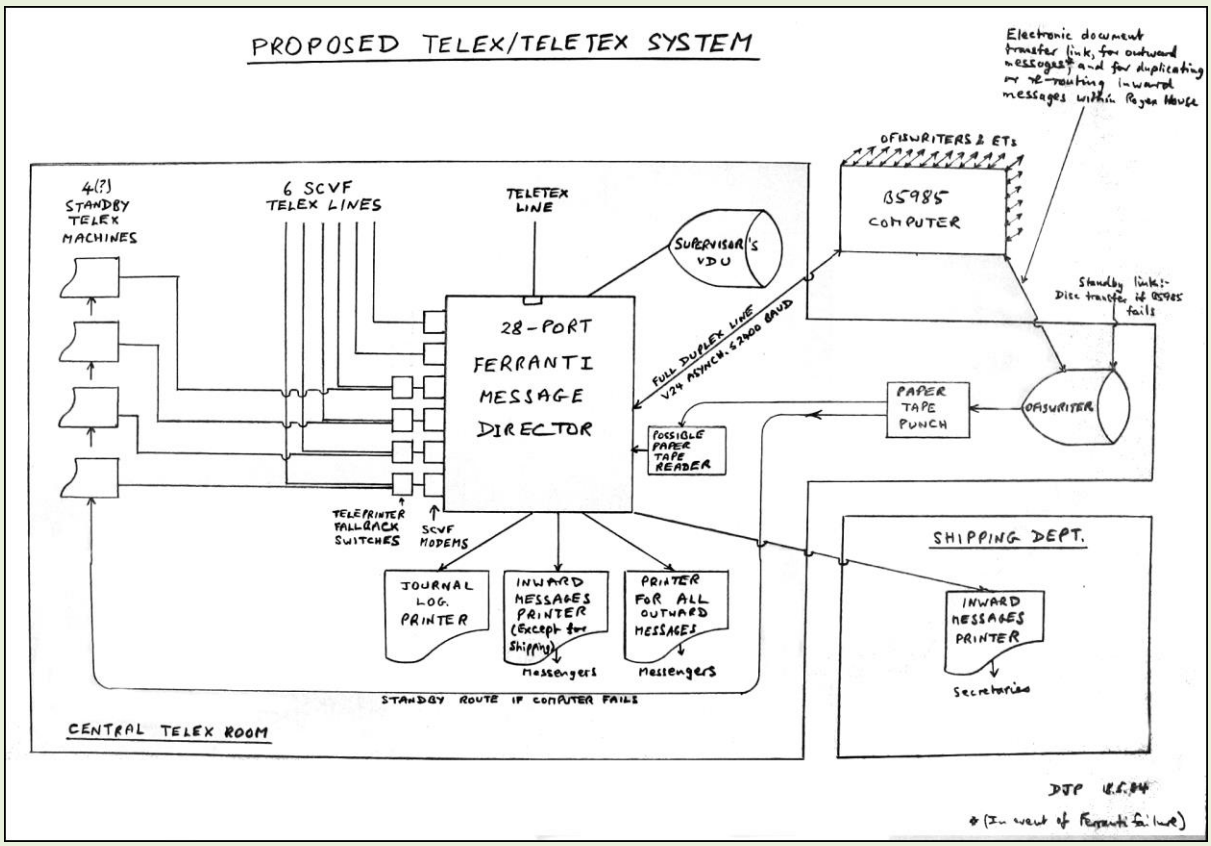
You will see from the above brochure, that another feature provided within OAS, was the ability to send and receive messages to clients and others by Telex from OFISwriters and lawyers' enquiry terminals. Telex was used mostly by the Shipping Department, who needed to communicate with organisations in the far east and in other locations around the world where electronic mail or fax was not then available.

We needed a specialised computer, connected to the Telex network and which could be linked into the firm's network. Two systems were on the market which I considered: one from Ferranti, called a Message Director, the other from a much smaller company called Chernikeeff. I studied the two systems and wrote an eleven page report in November 1983 which concluded that we should install the Ferranti system. In a document dated 18th May 1984, I showed a diagram indicating the structure of the system components, with fall-back capability in the event of failure of the Burroughs computer. Here it is:



One of our programmers spent several months writing software to integrate the Ferranti system into the Burroughs network. (British Telecom ceased operating the standard Telex network in 2004, and telex is not used any more by the firm – I understand that there is no longer a shipping department operating within the firm).

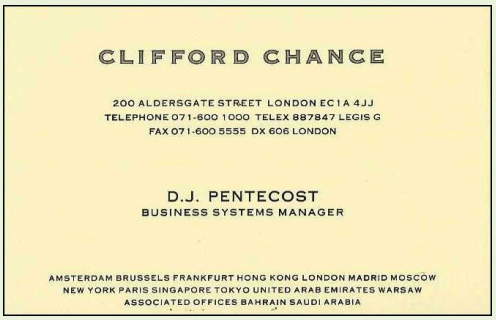
In early 1987, there came what seemed to me to be regarded by many within Coward Chance as shocking news. Secret talks had been going on between the two senior partners of Coward Chance and another large City law firm: Clifford-Turner. A merger was announced in February 1987, surprising the City as a whole, and making national and international news. The new firm would be one of the largest in the world; Clifford Chance, came into being on 1st May 1987.

It appeared to me that the immediate reactions of the staffs of the two firms could hardly have been more different; there were definite ‘them’ and ‘us’ attitudes, and there seemed to me to be a degree of despondency within Coward Chance, and, so I heard, elation within Clifford-Turner; it was reported that staff in the latter firm opened bottles of champagne in celebration, and that they regarded the merger as more of a take-over of Coward Chance.

I heard that many of the Coward Chance staff also saw the merger as a take-over by Clifford-Turner, although this was strenously denied by the more senior partners in the firm. Within Coward Chance, there had been a tremendous feeling of loyalty to the firm by its staff, perhaps partly because of its long history, resulting from a firm founded in 1801 by Antony Brown. By contrast, Clifford-Turner had not been founded until almost a century later. I think it was significant that the new firm, would after the merger have a Coward Chance man appointed as joint Managing Partner; my feeling is that this was to provide some reassurance for the former Coward Chance staff.

These differing sentiments lessened with time, but did not significantly begin to disappear until the two firms were physically merged. Plans were drawn up for the two firms to move in 1992 to amazing and massive new tower premises designed and built by Wimpey at 200 Aldersgate Street, very close to the Museum of London. After the move into one building, everyone began to develop a loyalty to Clifford Chance.

Here is my business card showing the new address:


CLIFFORD CHANCE

200 ALDERSGATE STREET LONDON EC1A 4JJ
TELEPHONE 071-600 1000 TELEX 887847 LEGIS G
FAX 071-600 5555 DX 606 LONDON

D.J. PENTECOST
BUSINESS SYSTEMS MANAGER

AMSTERDAM BRUSSELS FRANKFURT HONG KONG LONDON MADRID MOSCOW
NEW YORK PARIS SINGAPORE TOKYO UNITED ARAB EMIRATES WARSAW
ASSOCIATED OFFICES BAHRAIN SAUDI ARABIA

On the next page is a photo of me taken in August 2018 in front of part of 200 Aldersgate Street. Photos of tall buildings in narrow streets are difficult to obtain, and the enormity of the building cannot be properly appreciated from this picture

After I left the firm, it even outgrew the new building, and moved to its present location at 10 Upper Bank Street in Canary Wharf. It was a bold decision to move outside the City boundaries, but the firm had become so prestigious that it no longer needed to remain within the traditional law firms’ district of the City’s Square Mile.

Clifford Chance now also has a very small office in the City. By an amazing coincidence, these premises are in a relatively new office block at 4 Coleman Street, on the corner of White Horse Yard and Coleman Street. It was at the end of White Horse Yard where 16 Coleman Street used to exist, and where I worked from 1967 at Unit Trust Services Ltd.

Clifford Chance's first combined London premises, at 200 Aldersgate Street

Now back to my employment at Clifford Chance. With any merger, administrative staff in particular fear redundancies, but extraordinarily and comfortingly, a memo was issued to everyone saying that there would be none. And indeed there were none resulting from the merger as such, although when recession times hit the country in later years, redundancies did occur.

A man younger than me, had been appointed in charge of Information Technology (I.T.) at Clifford-Turner, and he was given the senior I.T. job over me, but I retained my job title as Business Systems Manager. Effectively I remained in charge of I.T. in the Coward Chance offices, and the I.T. Manager for the whole firm dealt with the computer systems in the Clifford-Turner building.

I shall now digress for a couple of paragraphs to describe a surprising event which happened six years earlier. There is huge irony in what happened regarding who became the new firm's I.T. Manager. Shortly after I joined Coward Chance, I was involved in a discussion about the problems of possible conflict of interest, which all large law firms have. I wrote a short paper in June 1981 on how the problem might be dealt with by using a computer system, and I discussed it with one of the partners who was interested in the subject. To my surprise, he said that I should also discuss it with one of the partners in Clifford-Turner, whom he knew well and who was also interested in the subject, and he arranged for me to go to their office, having sent a copy of my paper to him.

I duly met him, we discussed the ideas in my paper, and before I left, he surprised me by offering me a job as systems analyst for Clifford-Turner. I think that at that time they probably had no professional computer staff. But I had no interest in such a much more junior post than the one which I had at Coward Chance, and I declined the offer. I have often wondered what would have happened had I accepted. Would I then have found

myself in charge of Clifford-Turner's computer systems at the time when the merger would take place six years later, having developed for Clifford-Turner an ambitious system similar to the one which Coward Chance had at the time of the merger? And would I have been put in charge of Clifford Chance's systems?

Now to return to 1987. The most difficult problem for the merged firm was in fact Information Technology. Clifford-Turner had an IBM-based computer system, which was totally incompatible with the Burroughs system in the Coward Chance office. Both systems had to remain operating whilst a study was undertaken to decide how to proceed with I.T. The Coward Chance system was generally more advanced and comprehensive than the Clifford-Turner system, and the IBM computer at the Clifford-Turner office was nowhere near powerful enough to cope with the merged firm's requirements. So I hoped that the Burroughs system would triumph. But as time went on, it became clear that the OFISwriter was going to be displaced by more advanced machines, with larger screens – eventually the PC. At some point the OFISwriters would all have to be replaced.

There was rivalry between proponents of each system, including amongst the legal staff, not just the computer staff; an improvement would be made to one system, and the other system would be upgraded similarly. Eventually the partners decided to take action which pleased neither side, so it appeard to me: both systems would be scrapped, and a completely new system would be developed, taking the best system ideas from each of the existing ones. An IBM AS/400 computer was chosen, and I expressed reservations about it, because I thought that the model was not powerful enough to undertake the work for the entire firm, and IBM did not then have an upgrade, should that prove necessary. If I were proved right, the firm would find itself with a most intractable problem, unless IBM were able to introduce a more powerful model.

Development of the software for the new IBM computer went ahead, and it was found that the computer was indeed not powerful enough. But fortunately by that time, IBM had produced an upgrade, and this was installed. Clifford Chance had its first computer system able to serve the whole of the London office.

In 1990 and 1991 a recession hit the country's economy, and many companies went into liquidation, or were taken over or had to re-structure. There was as a result, a good deal of company business for law firms to undertake, to help deal with the crisis. But after that work was over, the recession was then felt by the law firms in 1992-1993, and many had to contract somewhat. In 1993 Clifford Chance made dozens of staff redundant, me included.

Ever since the merger in 1987, in spite of the promise of no redundancies, I had feared that one day it would happen, and indeed it did. I had spent a lot of time specifying a big new system called the Legal Information System, together with an outside consultant and one of our own staff. But the firm decided that it would be too expensive, and the project was scrapped. So in truth, at the time, I did not have very much work to do. I left the firm in May 1993 at a salary of £46,350.

‘Full Circle’. Whilst talking to a former colleague at the end of 2022, now retired from Clifford Chance, I learned of developments since the start of the Covid pandemic early in 2020. The huge set of offices at Canary Wharf had been closed, and employees had to work from home. In 2022, when the premises were re-opened, a degree of ‘desk-sharing’ was introduced, so that many of the rooms were not in use, and some employees worked partially from home. He told me that, ironically, the plan was, that when the lease of the Canary Wharf premises expires, the firm would move back to the traditional area of the City of London for law firms. A new building would be constructed, in Aldermanbury Square, very close to Royex House, which Coward Chance had occupied, and where I first started working for the firm.

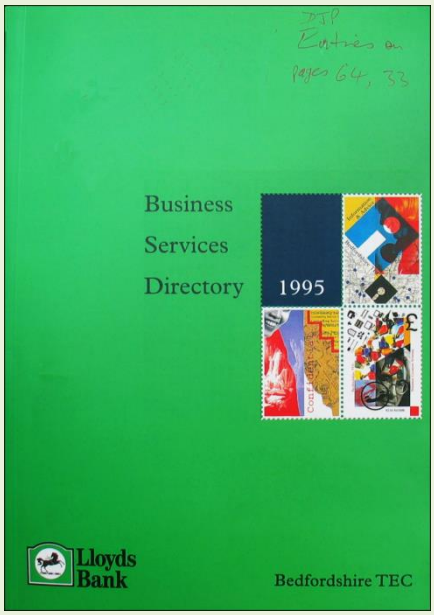
Chapter 10: INFORMATION TECHNOLOGY CONSULTANT

Before I left Clifford Chance, I thought about what I should do next. I knew that at the age of 53, I was highly unlikely to find a senior information technology post in another firm. I had had thirteen years' experience of the benefits of using computers in law firms, and it seemed to me that I was in an ideal position to make use of my knowledge, so I set myself up as an independent information technology consultant to law firms generally, working from home.

On my first day working from home, I telephoned a senior man in a quite a large London law firm, which I thought might have some problems to solve. He agreed that I should discuss the problems with him, and we met a day or two later. I spent the best part of a day there, giving advice, and next day writing it up in a report. I submitted a bill for £700, which was settled promptly. I was over the moon – this life seemed to be highly lucrative!

However it proved to be just beginner's luck – I never afterwards had such a financially profitable day.

I joined Bedfordshire TEC (standing for Training and Enterprise Council), who were running a new business scheme course, which provided some training in setting up and running new ventures. It was helpful, especially in making me produce a business plan, which was approved and resulted in my business being listed in the Bedfordshire Business Services Directory. Here is the cover of the 1995 issue, which that year listed my entries on pages 33 and 64.



I received a small income from Bedfordshire TEC for a number of months (it may have been a year), in order to help my business get started; this was a standard feature of the Government's TEC schemes.

I was subscribing to The Lawyer magazine, and I think it may have been in one issue where I read about the Law Society's plans to produce a directory of consultants advising law firms, in all kinds of areas, one being information technology. I made enquiries, and I received the following letter from the Law Society:

Legal Practice Directorate

Andrew Lockley
Director

THE LAW SOCIETY

50 Chancery Lane
London WC2A 1SX
Tel: 071-242 1222
Telex: 261203
Dx: 56 LOND/CHANCERY LN
Fax: 071-831 0057

OUR REF: LPD/70/12/PSU

Spoke Clive Baldon 24/1/94
He said code of practice doesn't apply if my client is a supplier of goods/services to the Solicitor & if any invoices should go to the solicitor

Direct Dial Number: 071-320 5782

20 May 1993

Dear Consultant

DIRECTORY OF CONSULTANTS FOR SOLICITORS

I am writing to you with reference to my letter of 2 April, or for the first time, if you were not originally on our database.

The Law Society intends to publish a Directory of Consultants for Solicitors early this summer. The Directory targets solicitors in private practice in search of a comprehensive listing of consultants who specialise in advising the legal industry and/or other professional service firms in one or more of the following areas: business planning and strategy, finance, human resources, information technology, marketing and quality. The Directory will coincide with the publication of the Law Society's Practice Management Standards in keeping with the Society's emphasis on quality and client care. This is an excellent opportunity for you to reach your market or potential market.

Attached you will find sample page layouts for the Master Index of Consultants, the Alphabetical Listing, and the Regional Listing as well as the Table of Contents to give you a "feel" for the book and how your entry would look. We believe this design will greatly simplify the user's task of finding and evaluating an entry within the Directory.

Besides the sample layouts and table of contents from the Directory, you will find enclosed the following:

1. The Law Society's Listing Procedure.
2. The Code of Practice with which all consultants must comply.
3. The data input form for your completion.
4. An application form which includes key dates for submission. Please note that we have attempted to keep the application fees as low as possible.
5. A referee's questionnaire, referee form letter and Form A for you to copy and send to your referees. The minimum acceptable number of references is three for the first specialism applied for and an additional one for each other specialism applied for. At least one of the references must be from solicitors in private practice; the others may be from other professional service firms. Former clients may provide references for more than one specialism.

The questionnaire employs a simple multiple choice format that should be quick and easy for your clients to complete. On the form, we request that your client returns the reference, once complete, directly to us and there is a slip for them to advise you that they have done so. ***We cannot qualify you for entry to the listing until we receive your references. Therefore, please note that the referee form letter requests that the questionnaire is returned to the Law Society on or before Wednesday 16 June.***

It will not be possible to include you in a particular specialism in the listing if the satisfactory references have not been received by this date. Include a self addressed envelope addressed to me at the Law Society when you send these forms to your referees.

Information from the references will not be published in the Directory, although, in the event that they are unsatisfactory, we may decline to list your consultancy. Should a problem be disclosed by the references, we will contact the consultancy before making a decision. Please refer to the Listing Procedure for further information. I look forward to your application.

The Submission of Your Consultants Details

The onus is on you to return your details to me by ***Wednesday 9th June*** at the latest and earlier than that if at all possible. We will not be able to follow up applications for listing which have not been received.

Next Steps

Your data will then be input onto our computer, checked and printed. You will then be sent your laser proof and any reference tables which affect you for checking and we will require confirmation from you by fax or phone that everything is correct by the schedule date.

There is a reason for the tight timetable. The Law Society has agreed its Practice Management Standards (copies of which may be ordered from the Law Society Bookshop on 071-242 1222) and wishes to ensure that solicitors have access to this directory at the earliest possible opportunity so that solicitors may seek consultancy advice in the appropriate circumstances.

I would also like to draw your attention to the following:

1. A conference for consultants organised by the Law Society has been provisionally fixed for Tuesday 14th September in Birmingham. Further details on venue, content and price will be sent to listed consultants.

2. It is intended that the lists should be reviewed annually and the facility to advertise may well be included in next year's edition.

In the meantime if you have further enquiries please contact me or my secretary Paula Crowhurst on 071-320-5782. Alternatively you may speak to my colleague Karen Monnick, Business Adviser who is also working on this project.

Yours sincerely

Clive Baldon

Law Society Listed Consultant

Clive Baldon
Business Development Manager
Practice Support Unit

It was not a very simple procedure to get oneself listed by the Law Society, but I asked for and received the required references, one of which must have been from Clifford Chance (although I have not kept it), and I was duly accepted as a Law Society Listed I.T. Consultant:

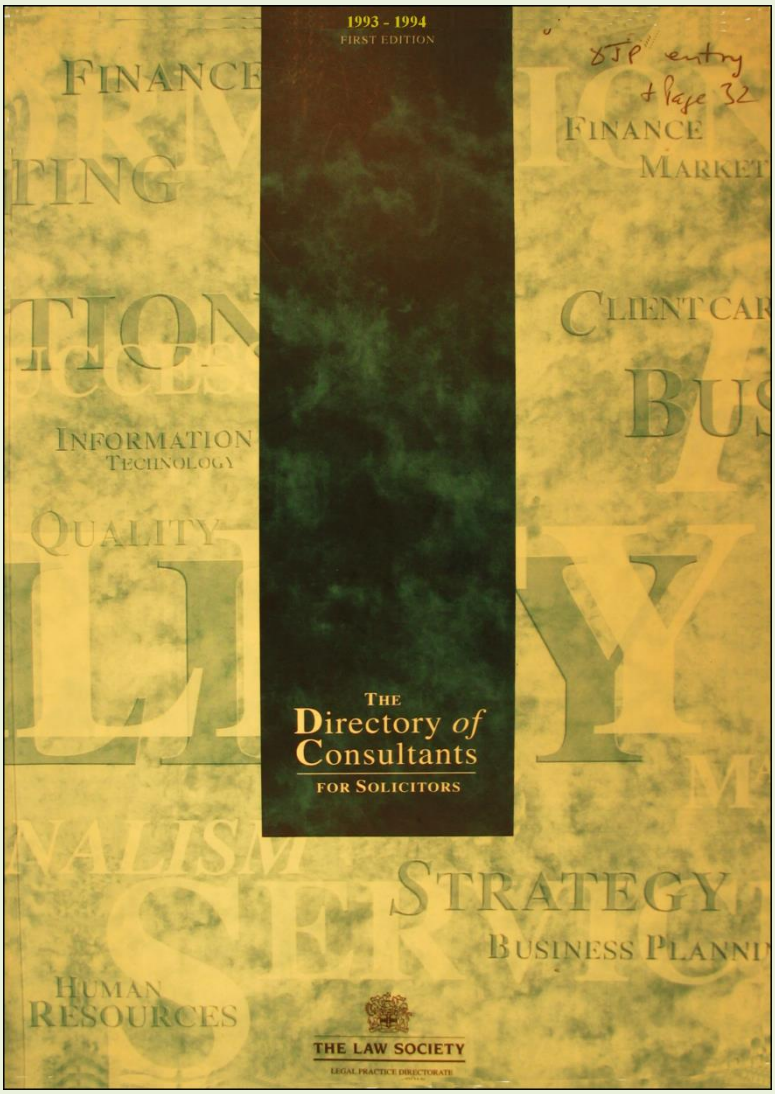
Information Technology Consultant
Specialist in systems for solicitors

D. J. PENTECOST, MBCS, MIDPM

Woodlands, Heath Park Road,
Leighton Buzzard, Beds. LU7 8BB
Tel & Fax: 0525 377193

A Law Society Listed I.T. Consultant

My entry in due course appeared in the Law Society's Directory:



There were brief details about my services in several tables within the directory, but the main entry appeared as follows:

THE
Directory *of* Consultants
FOR SOLICITORS

1993–1994

THE LAW SOCIETY

D.J. Pentecost Torrington Cottage, Church Path, Finchley, London N12 8GP
Tel: (081) 445 9566, Contact: David Pentecost, Consultant

I have worked for over thirteen years for two large London-based international law firms, in charge of information technology and as business systems manager. Prior to that, I had over seventeen years in the computer industry, with software houses, computer manufacturers and commercial computer users. Having worked closely with solicitors for many years, I understand very well how they work, how law firms function and their computing needs. In the 80s, I developed integrated, client and matter, time recording, accounting, billing and electronic mail systems. More recently I specialised in legal know how systems, particularly document management, including text and image storage and retrieval. I have personal experience of voice recognition word processing. At present I offer services only to law firms, and regardless of practice size. Recent work: with firms of up to thirty partners, providing advice on I.T. Strategy, precedent management, word processing systems, and in-house computer project development. I am willing to provide consultancy without geographical constraints, but expect most of my work to be undertaken for practices in the South and Midlands. I am a member of the Society for Computers and Law, the British Computer Society and the Institute of Data Processing Management.

Firm Details

Date Firm established	March 1993	*Number of Partners/Directors*	1
Initial Free Consultation	Yes – up to 2 hours free within 50 miles	*Number of Consultants*	1, 1 in legal
Membership of Professional Bodies	BCS, IDPM, SCL	*Other offices*	–

	Area of Specialisation	Completed projects in last 18 months		DTI scheme offered
		Legal Projects	Total Projects	
Business Planning/Strategy				
Finance				
Human Resources				
Information Technology	•	2	2	
Marketing				
Quality				

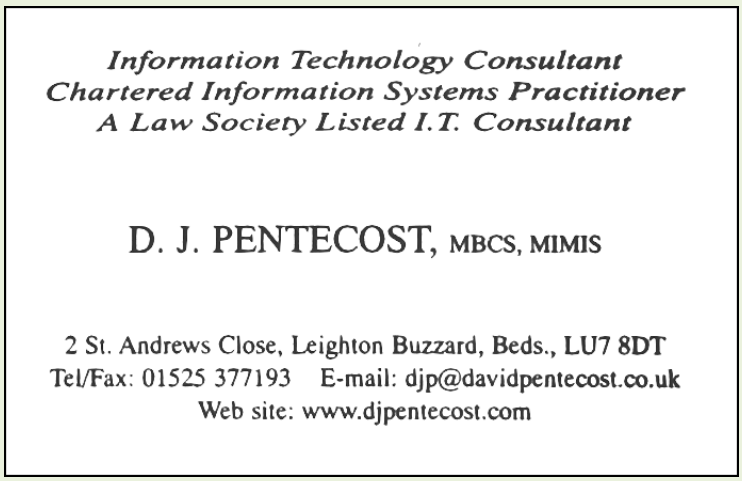
You may notice that in the above edition of the directory I used my parents' address in Finchley, in order to try to attract business from solicitors in and around London. From time to time after my mother died, I did live there with my father, and travelled to London whilst doing work for a few clients.

I wrote to law firms, announcing my services, and picked up some business, especially locally in Bedfordshire and Buckinghamshire. It was a time when many law firms were still using electric typewriters, and they needed advice and help in setting up word processing systems. Conversion to word processing systems in the legal world almost always involved installing WordPerfect; I trained secretaries for clients from time to time, and developed software to improve their use of the product. It was some years before Microsoft's Word started to become dominant in the world generally, and Microsoft provided within Word, a conversion program to read WordPerfect documents in order to capture the legal market in particular.

The move to word processing (WP) systems within the legal world was rapid, and effectively was forced on them. If a firm did not have a WP system, and another with whom they were dealing did, the former could only receive a document from the latter rapidly by hand or by fax; then the revised text could not be modified and sent back without retyping, and then further typing. Clients, especially corporate clients, in due course wanted to communicate with their own law firm by email too, which was another important influencing factor.

The most significant requirement by law firms for I.T. advice, especially for all but the very smallest firms, was for help in choosing an accounting and time recording system, and getting it operational. I had to examine the products of several software houses which had developed and were still improving systems aimed at law firms. This involved travelling to meet the suppliers at their development offices, learning their systems and plans, and even in some cases advising them on improvements which they needed to make before I could recommend their products to law firms.

After moving house in 1994, I had new business cards printed by Pentecost Printing:

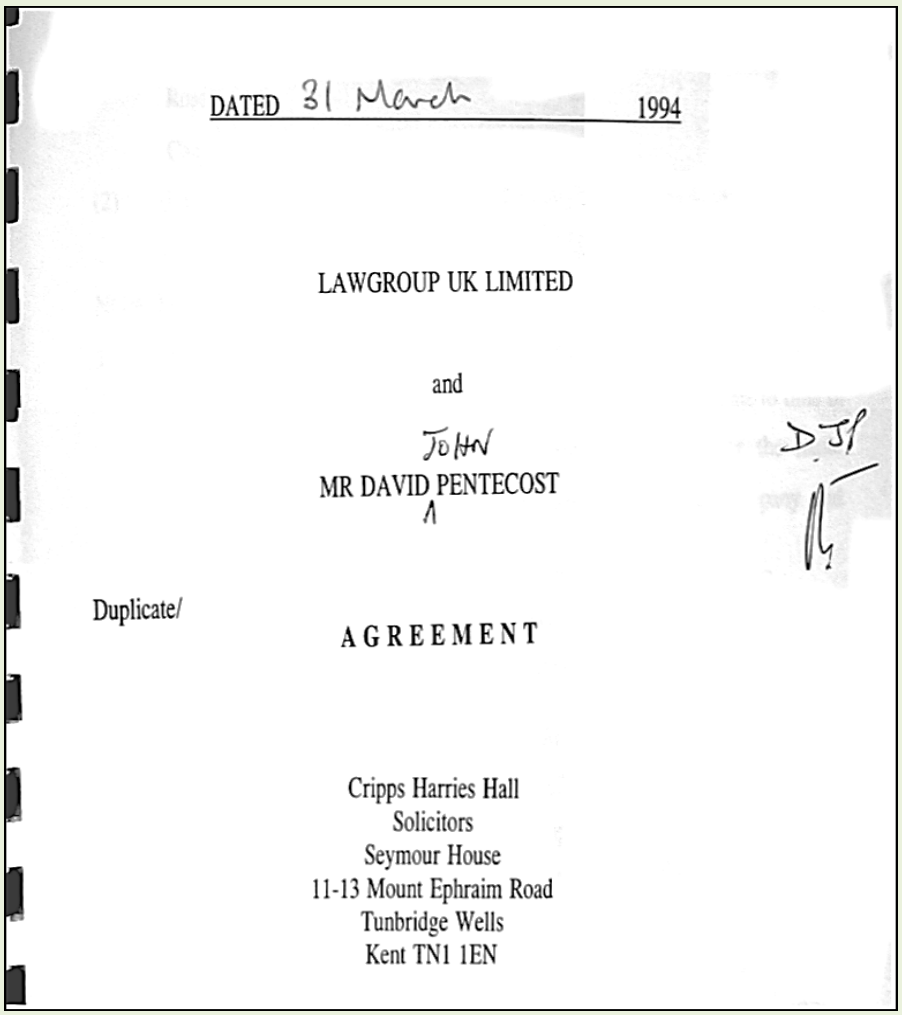

Information Technology Consultant
Chartered Information Systems Practitioner
A Law Society Listed I.T. Consultant
D. J. PENTECOST, MBCS, MIMIS
2 St. Andrews Close, Leighton Buzzard, Beds., LU7 8DT
Tel/Fax: 01525 377193 E-mail: djp@davidpentecost.co.uk
Web site: www.djpentecost.com

(I eventually abandoned my own domain names which you can see on the above card, at about the time when I started becoming involved in developing websites).

Work was not easy to get, in spite of the measures I had taken. I was sustained by a few clients, particularly one in Aylesbury, for whom I did a significant amount of work.

I had to take steps to gain more clients. I became aware of the fact that some law firms were beginning to co-operate with each other, not in the usual way in which law firms have to work together on legal matters, but in a different way, by becoming associated with a separate consultancy company which advised them on the non-legal aspects of their businesses, their methods of working, their marketing methods, training and so on.

In an edition of the Law Society's Directory of Consultants, I found a few such consultancy companies, and the most significant one was called LawGroup UK, based in Caterham, Surrey. I looked at their advertising material, noticing what services they offered, and observed that they did not offer I.T. advice at all. I contacted the managing director and made an appointment to see him, telling him that his company had a significant gap in its services, which should be filled. He agreed, and thought about how to proceed, considering whether to take me on as an employee, something which I had not wanted or requested. In the end we had a contract drawn up, which meant that all law firms in the group (more than 200) would be able to access my services for a fee, whilst I remained an independent consultant, working through LawGroup.



DATED 31 March 1994

LAWGROUP UK LIMITED

and

JOHN
MR DAVID PENTECOST

DJP

Duplicate/

AGREEMENT

Cripps Harries Hall
Solicitors
Seymour House
11-13 Mount Ephraim Road
Tunbridge Wells
Kent TN1 1EN

We created a new arm of LawGroup called LawGroup Technology Services (LTS), and produced a card, printed on both sides and folded to make four pages:

For more information, contact:

LawGroup Technology Services
Orbital House, 85 Croydon Road
Caterham, Surrey CR3 6PD

Peter Collier
Tel: 0883-341341
Fax: 0883-340066
DX: 36806 Caterham

or David Pentecost on 0525-851504

LAWGROUP UK

LAWGROUP TECHNOLOGY SERVICES

Your route to impartial advice

ELIMINATING THE FEAR

Whether your firm is looking to make a substantial investment in computerisation or simply wants to ensure that it is maximising the capabilities and benefits of its existing systems, LawGroup Technology Services is here to help you.

Below are just some of the typical questions we are asked:

> ***"There is so much software about: how do I begin to decide what will be best for us?"***

> ***"We invested £50,000 in this system but we don't get the information we wanted. I need some help."***

> ***"The new software we want cannot run on our old terminals - I wish I'd known that two years ago. What we need is a strategy."***

> ***"I hear that voice recognition word-processing is already available. How could I benefit from it, and what would the impact be on my practice?"***

Nowadays the legal profession is awash with opportunities to invest vast sums of money in computerisation. Many practices however, simply do not have the knowledge, skills, or time, to ensure that the investment they make is both appropriate and cost-effective.

LawGroup Technology Services provides advice which is independent of industry suppliers, who usually have their own products' interests at heart. The service is designed to help eliminate fear of the unknown; provide practical advice; maximise your investment, and through the group buying power of LawGroup UK, save you money.

With over 30 years of experience in information technology we can guide you safely through this difficult and often confusing market.

FEATURES OF OUR SERVICE

- Thirteen years of IT experience within the profession
- IT HealthCheck often at no cost
- Totally independent advice
- Group discounts
- Training and one-to-one coaching.

David Pentecost is LawGroup Technology Services' Consultant. He has over 30 years' experience in this field and over 13 in the legal profession.

David is a Law Society listed consultant, and a member of the British Computer Society, the Institute of Data Processing Management and the Society for Computers & Law.

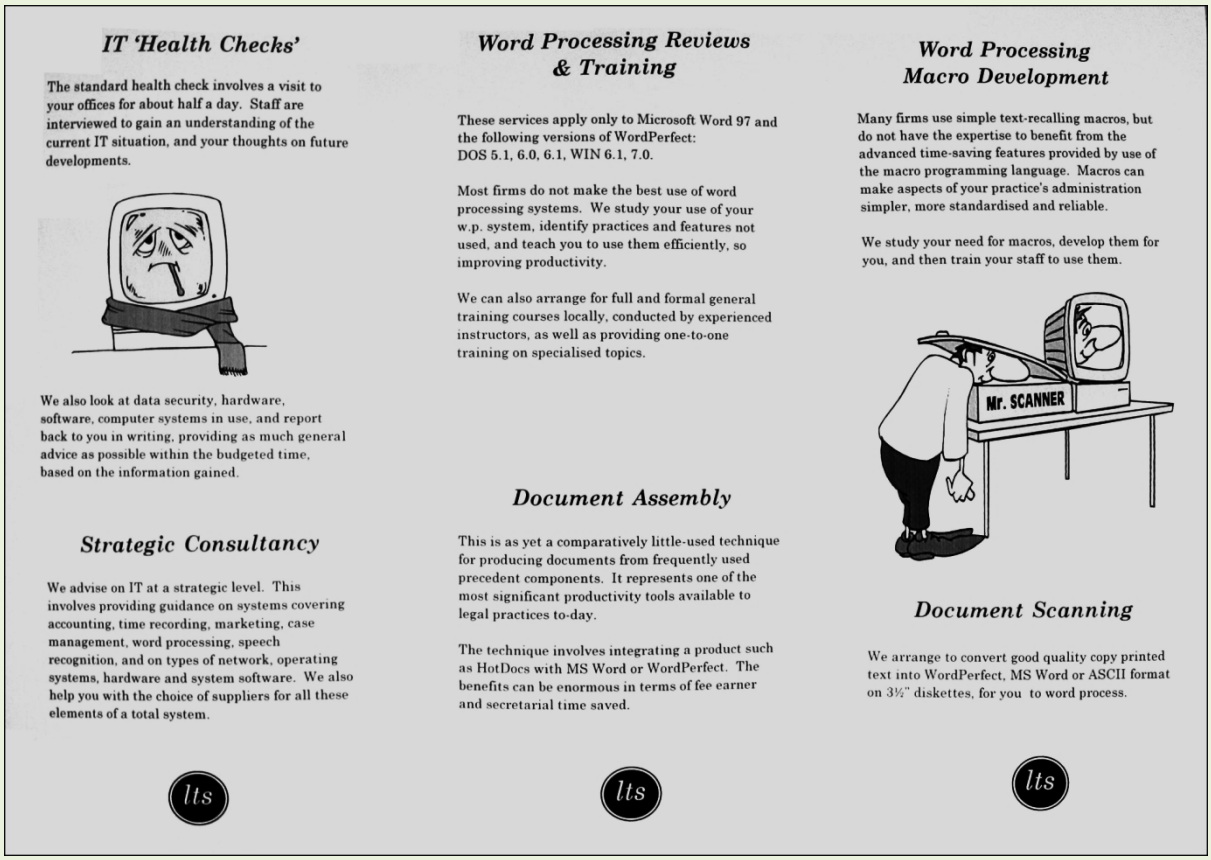
This was distributed to law firms within LawGroup, showing the telephone number of the second line which I had installed at my home, with a blue handset, so that I would know when I was being called by a LawGroup firm.

LawGroup also had some new business cards printed for me to use, after British Telecom lengthened many telephone numbers:

LAWGROUP UK
DAVID J PENTECOST, MBCS, MIDPM
A LAW SOCIETY LISTED IT CONSULTANT
CHARTERED INFORMATION SYSTEMS PRACTITIONER
LAWGROUP TECHNOLOGY SERVICES
ORBITAL HOUSE, 85 CROYDON ROAD, CATERHAM, SURREY CR3 6PD
TEL 01525-851504 FAX 01883-340066 DX 36806 CATERHAM
E-MAIL davidpentecost@link.org

Together we produced some fold-up leaflets which were distributed to all firms in the group, setting out specific services which were not defined on the original publicity cards:

W.P. Text Format Conversion
Most word processor package text formats can be converted from one format to another. We undertake this either as a standard service, or arrange for conversion software to be written where necessary.
New LINK
LINK is a well-established specialised legal information and electronic document transfer service. We can help you to become part of the fast-growing LINK network, which also provides full Internet access for the World Wide Web and e-mail.
Help Line
We operate a telephone IT advice service on 01525 851504.
lts
For further information, please contact:
David Pentecost
MBCS, MIMIS,
Law Society Listed IT Consultant
Chartered Information Systems Practitioner
on
Tel 01525 851504
Fax 01883 340066
or write to
LawGroup Technology Services
Orbital House
85 Croydon Road
Caterham
Surrey
CR3 6PD
DX 36806 Caterham
E-mail: 101714.234@Compuserve.Com
LAWGROUP UK
lts
LawGroup Technology Services
LAWGROUP UK



IT 'Health Checks'

The standard health check involves a visit to your offices for about half a day. Staff are interviewed to gain an understanding of the current IT situation, and your thoughts on future developments.

We also look at data security, hardware, software, computer systems in use, and report back to you in writing, providing as much general advice as possible within the budgeted time, based on the information gained.

Strategic Consultancy

We advise on IT at a strategic level. This involves providing guidance on systems covering accounting, time recording, marketing, case management, word processing, speech recognition, and on types of network, operating systems, hardware and system software. We also help you with the choice of suppliers for all these elements of a total system.

lts

Word Processing Reviews & Training

These services apply only to Microsoft Word 97 and the following versions of WordPerfect: DOS 5.1, 6.0, 6.1, WIN 6.1, 7.0.

Most firms do not make the best use of word processing systems. We study your use of your w.p. system, identify practices and features not used, and teach you to use them efficiently, so improving productivity.

We can also arrange for full and formal general training courses locally, conducted by experienced instructors, as well as providing one-to-one training on specialised topics.

Document Assembly

This is as yet a comparatively little-used technique for producing documents from frequently used precedent components. It represents one of the most significant productivity tools available to legal practices to-day.

The technique involves integrating a product such as HotDocs with MS Word or WordPerfect. The benefits can be enormous in terms of fee earner and secretarial time saved.

lts

Word Processing Macro Development

Many firms use simple text-recalling macros, but do not have the expertise to benefit from the advanced time-saving features provided by use of the macro programming language. Macros can make aspects of your practice's administration simpler, more standardised and reliable.

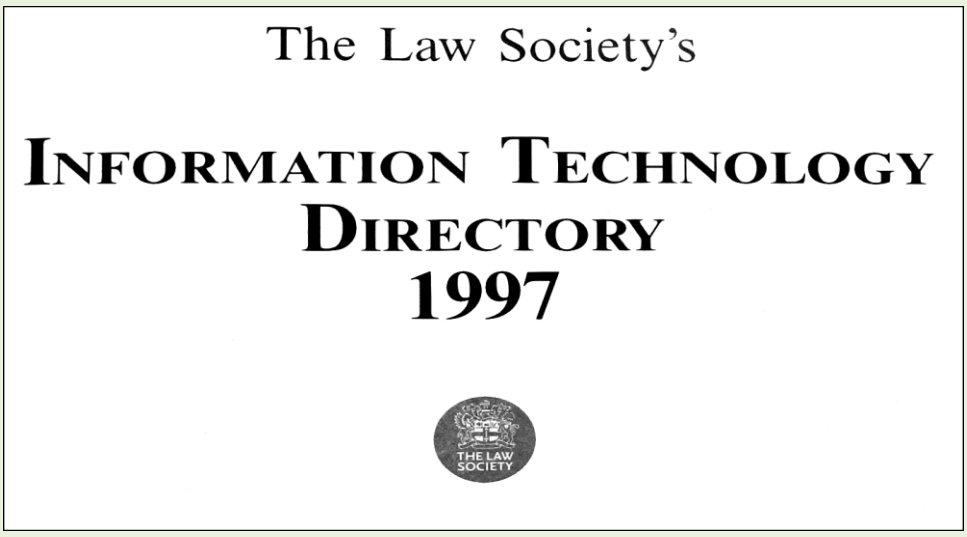
We study your need for macros, develop them for you, and then train your staff to use them.

Document Scanning

We arrange to convert good quality copy printed text into WordPerfect, MS Word or ASCII format on 3½" diskettes, for you to word process.

lts

One of the arrangements we made was that I would on request do a free half day 'I.T. health check' for a firm within the group, and write a brief report, recommending what actions could with advantage be taken to make improvements. For work resulting, I would either quote a fixed fee, or charge by the hour, plus travel expenses. My bills would be sent to LawGroup's office, who would settle them with me each month, and LawGroup would invoice the client law firms. This arrangement proved very satisfactory for me, and provided me with a generally good income almost every month.



The 1997 edition of the the Law Society's Information Technology Directory, had the following entry for my services through LawGroup:

LawGroup Technology Services (LTS)

Head Office: Orbital House, 85 Croydon Road, Caterham, Surrey CR3 6PD

Tel: 01525 851504
Fax: 01883 340066
E-Mail: 101714.234@Compuserve.Com

Contact: David Pentecost MBCS, MIMIS, IT Consultant and Chartered Information Systems Practitioner
Business established in 1989 (LawGroup), 1993 (LTS)
No. of Directors 6
No. of Staff: 31

SERVICES
Target firm size: All
Support Services
Consultancy: in-house; Installation: third party; Training: in-house, third party; Facilities Management: third party; Maintenance: in-house, third party
On Site Support
Helpdesk available
Normal office hours

Company Profile

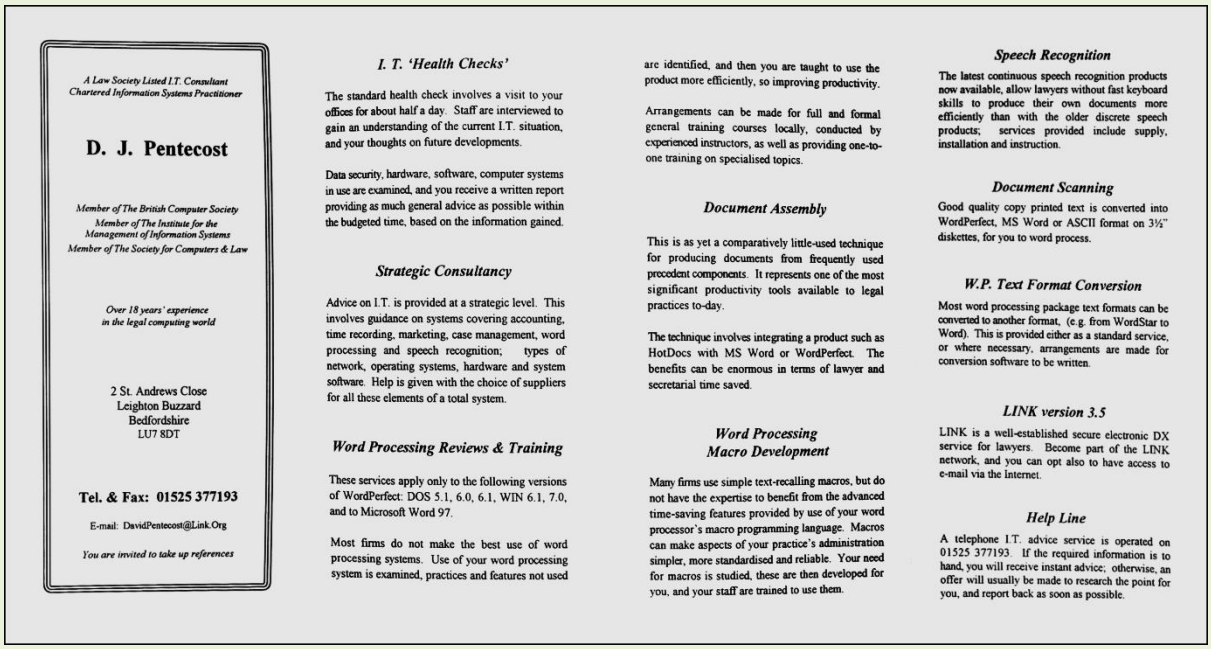
LTS is the information technology services arm of LawGroup UK, specialising in providing independent advice and practical assistance for law firms throughout the UK; our expertise in this field goes back to 1980. Originally set up to provide services for member firms within the LawGroup network, we now offer these services to all law firms. *IT Health Checks*: The standard service involves visiting your offices, and then reporting to you in writing. *Strategic Consultancy*: Guidance on systems covering accounting, time recording, marketing, case management, word processing and speech recognition; types of network, operating systems, hardware and system software. Assistance with choice of suppliers for all these elements of a total system. *Word Processing Reviews*: Many firms make inadequate use of word processing. We improve your productivity by identifying methods and features you do not use, and teach you to use them efficiently. *Document Assembly*: This as yet comparatively little-used technique for producing documents from frequently used precedent components, represents one of the most significant productivity tools available to legal practices today. We assist with the development work. *Word Processing Macro Development*: Many firms use simple text-recalling macros, but lack expertise to benefit from time-saving features provided by advanced use of the macro programming language.

Working as LTS kept me generally very busy. Because the law firms of the group were all over the country, I had to do a good deal of travelling, not just by car, but preferably when I could, by train. The train was more relaxing and allowed me to write reports on

the return journey, whilst the discussions were fresh in my mind. I had the pleasure of visiting parts of the country which I had never been to before, for example in the north-east. On one or two occasions I had to fly to Scotland, and on several occasions I visited a law firm in Wales, for whom I did quite a lot of work, specifying new systems and helping them to choose a computer system supplier.

Each year, LawGroup held a conference in a large hotel somewhere, usually in a different part of the country on each occasion. I took part in one of these conferences, and had to prepare an illustrated lecture. It was a little unnerving, standing on a stage and lecturing to a few hundred lawyers, advising them how they might make use of technology in their offices; but all went well. It was at the time when speech recognition was being considered for use in law firms and elsewhere, and my lecture included a demonstration.

I also continued doing work for a few law firms locally, which were not part of LawGroup, and I decided to print some leaflets for my own practice using some ideas which were included in the LawGroup consultancy leaflet:



A Law Society Listed I.T. Consultant
Chartered Information Systems Practitioner

D. J. Pentecost

Member of The British Computer Society
Member of The Institute for the Management of Information Systems
Member of The Society for Computers & Law

Over 18 years' experience in the legal computing world

2 St. Andrews Close
Leighton Buzzard
Bedfordshire
LU7 8DT

Tel. & Fax: 01525 377193

E-mail: DavidPentecost@Link.Org

You are invited to take up references

I. T. 'Health Checks'

The standard health check involves a visit to your offices for about half a day. Staff are interviewed to gain an understanding of the current I.T. situation, and your thoughts on future developments.

Data security, hardware, software, computer systems in use are examined, and you receive a written report providing as much general advice as possible within the budgeted time, based on the information gained.

Strategic Consultancy

Advice on I.T. is provided at a strategic level. This involves guidance on systems covering accounting, time recording, marketing, case management, word processing and speech recognition; types of network, operating systems, hardware and system software. Help is given with the choice of suppliers for all these elements of a total system.

Word Processing Reviews & Training

These services apply only to the following versions of WordPerfect: DOS 5.1, 6.0, 6.1, WIN 6.1, 7.0, and to Microsoft Word 97.

Most firms do not make the best use of word processing systems. Use of your word processing system is examined, practices and features not used are identified, and then you are taught to use the product more efficiently, so improving productivity.

Arrangements can be made for full and formal general training courses locally, conducted by experienced instructors, as well as providing one-to-one training on specialised topics.

Document Assembly

This is as yet a comparatively little-used technique for producing documents from frequently used precedent components. It represents one of the most significant productivity tools available to legal practices to-day.

The technique involves integrating a product such as HotDocs with MS Word or WordPerfect. The benefits can be enormous in terms of lawyer and secretarial time saved.

Word Processing Macro Development

Many firms use simple text-recalling macros, but do not have the expertise to benefit from the advanced time-saving features provided by use of your word processor's macro programming language. Macros can make aspects of your practice's administration simpler, more standardised and reliable. Your need for macros is studied, these are then developed for you, and your staff are trained to use them.

Speech Recognition

The latest continuous speech recognition products now available, allow lawyers without fast keyboard skills to produce their own documents more efficiently than with the older discrete speech products; services provided include supply, installation and instruction.

Document Scanning

Good quality copy printed text is converted into WordPerfect, MS Word or ASCII format on 3½" diskettes, for you to word process.

W.P. Text Format Conversion

Most word processing package text formats can be converted to another format, (e.g. from WordStar to Word). This is provided either as a standard service, or where necessary, arrangements are made for conversion software to be written.

LINK version 3.5

LINK is a well-established secure electronic DX service for lawyers. Become part of the LINK network, and you can opt also to have access to e-mail via the Internet.

Help Line

A telephone I.T. advice service is operated on 01525 377193. If the required information is to hand, you will receive instant advice; otherwise, an offer will usually be made to research the point for you, and report back as soon as possible.

There came a time when I began to be uneasy about doing work for LawGroup firms, in spite of having good personal relationships with lawyers in the firms. LawGroup had always been very good at settling my bills to them, but increasingly, there were longer and longer delays. At one point I was waiting for a whole year before the bills were paid, and it was then that I was thinking of refusing to accept any more work for LawGroup.

I rarely visited the LawGroup office in Caterham, so I did not have any feel for how things were, and what the atmosphere was like. One day I learned that the managing director with whom I had set up LTS had left LawGroup. So it seemed to me that something had been going wrong in some way with LawGroup during the previous year. In due course, a new manager whom I did not know contacted me, saying that the group no longer wished to have an outsider acting for LawGroup. I was stunned: it seemed to me that he was not aware of the work which I had been doing, or that I had a formal signed

agreement with LawGroup. I decided not to argue the point, especially because I had been funding LawGroup's LTS activities for about a year, and it was a relief for that position to end. The situation must have been bad in some way in Caterham which I knew nothing about. But all my invoices were settled, which was also a relief.

My connection with LawGroup ended in around 1999, as far as I can recall. But I continued doing work for a few non-LawGroup firms actively until about 2003.

In 1996 Microsoft brought out its first website development software, called FrontPage. I bought a copy in 1998 or 1999, and taught myself to develop websites, at first simple ones by today's standards. I decided to offer website development services, not only to law firms, but to any business, however small. I bought the domain a1webdesign.co.uk, initially for a two year period, and renewed it several times until eventually giving up after retiring from the information technology world.

Nominet.uk

THE UK INTERNET NAMES ORGANISATION

Registration Certificate

for the Domain Name

a1webdesign.co.uk

for

David J Pentecost

5000348702

W Black

Managing Director

Valid for two years expiring on

04 Jul 2001

1000348702

So I added another activity to my consultancy business, and had some additional business cards printed in July 1999:

A1 Web Design
Internet Web Site Development Services
D. J. PENTECOST, MBCS, MIMIS
Information Technology Consultant
Chartered Information Systems Practitioner
2 St. Andrews Close, Leighton Buzzard, Beds., LU7 8DT
Tel/Fax: 01525 377193 E-mail: djp@a1webdesign.co.uk
Web site: www.a1webdesign.co.uk

As well as developing and uploading my own website to the Internet, I did some press advertising for my website services, and received enough enquiries to keep myself fairly busy. The businesses were extremely varied in nature; they were mostly small companies, and about half of them sole traders, and I learned a great deal about types of business with which I had never had any previous contact.

One example which comes to mind was for a ladies' oriental fashion house based in Paris. The website had to be developed in both English and French; at last the French which I learned at school had actually helped me to earn some money, instead of just being useful from time to time in life generally.

Here is a list of some business types for which I developed websites:

Airport chauffeur
Builder
Business registration services
Cable accessories supplier
Car purchase financing
Chamber music festival
Classical music club
Cleaning company
Dental ceramics laboratory
Explosive protection exporter
Finance companies
Fish and chip shop
Flight protection case maker
Flooring installer
Football coaching
Handyman
Lawyers
Machine tools supplier
Mailing company
Map designer
Oriental dress maker
Osteopath
Pet shop supplier

Power tools supplier
Printing company
Psychotherapist
Public house
Religious book promoter
Sculptor
Vintage car sales
Violinist

Another customer was a man who rented out holiday homes in France. That was a difficult development for me, because it required that for the first time I learn how to integrate a relational database into a website. I had to acquire and learn how to use some special software from Microsoft to permit the integration of an Access database into a FrontPage website.

That development became important to me and to the estate agent employee in Cyprus who sold me my flat in Limassol in 2003. She resigned her post to set up her own estate agency. I told her about the website I had developed for my customer dealing in French properties. She became a good friend, and I said that I would like to redevelop the site free of charge for her, to help her with her new Cypriot estate agency.

The site was successful and had a few hundred properties on it for about a decade, until disaster struck. Without warning, suddenly the site ceased to work. The Internet Service Provider (ISP) in the UK without warning had updated their server with new software, which was incapable of supporting Microsoft's Front Page software and its extensions. They said that they had no staff who understood the old server software and there was nothing they could do. I searched to find another ISP who would be willing to host the site, and eventually I found one in the USA. The site was successfully transferred and ran for a while, until the new ISP again without warning stopped operating and he vanished. It was time to abandon the site with the out of date software, and develop a new one. I was by then retired and unfamiliar with the latest technologies; I could learn, but I said that it would be unwise from the future site maintenance point of view, and that a new developer would need to be found, which is what happened in due course.

Gradually I ended my relationships with nearly all my customers as I approached age 65, by which time I was living full time in Cyprus, and they migrated to other developers. I continued to assist a few of them from Cyprus for a few years.

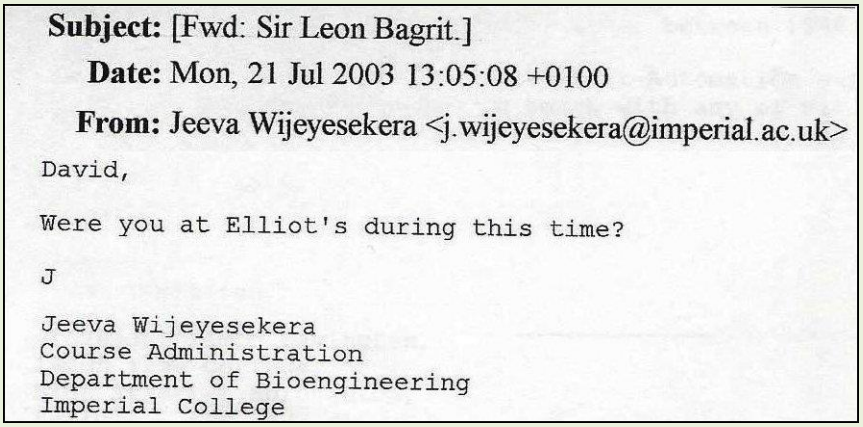
My paid working life had come to an end, and I could spend my time at leisure, playing tennis, bridge, piano and composing. Or so I thought, but much more hard work was to come, although unpaid.

Chapter 11: OUR COMPUTER HERITAGE

Leon Bagrit was a great innovator, who in 1947 had acquired control of Elliott Brothers, where I had worked from 1960 to 1962. In 1958, Elliotts and Associated Automation Ltd were merged to form Elliott Automation. Bagrit's company pioneered the use of computers in industry and made automation a household word. In 1964 he gave six Reith Lecture broadcasts for the BBC, entitled 'The Age of Automation'.

He died in 1979, and I think that it was after his death when the Bagrit Trust was set up. The Bioengineering Department of Imperial College London was named the Sir Leon Bagrit Centre in his honour in 1991, when the Bagrit Trust provided funding for it to be built.

On 21st July 2003, I received an email from Jeeva Wijeyesekera, a friend who worked at Imperial College in London. She had received an email on 9th July from Professor Simon Lavington of Essex University, who was enquiring about Leon Bagrit. Lavington was asking if any Bagrit papers were held at Imperial College, which might help him to write his book about Elliott computers built at Borehamwood. What good fortune it was, that not only had Lavington chosen to address his enquiry to her, but that she also recalled that I had worked at Elliotts decades previously!



Subject: [Fwd: Sir Leon Bagrit.]

Date: Mon, 21 Jul 2003 13:05:08 +0100

From: Jeeva Wijeyesekera <j.wijeyesekera@imperial.ac.uk>

David,

Were you at Elliot's during this time?

J

Jeeva Wijeyesekera
Course Administration
Department of Bioengineering
Imperial College

I asked her to find out more, and she was able to tell me how to get in touch with Professor Simon Lavington who was also seeking former employees of Elliotts who had worked there in the 1950s and 1960s. Simon Lavington was leading a project to document on the Internet, the story of early British computers, as well as writing his book about Elliotts.

I made contact with him, and he sent me an email explaining his project, which was to create a definitive website about the history of British computers, for the benefit of future historians and students of computers, whilst some of the pioneers were still alive to tell the tale. He was at the time dealing just with computers made by Elliott Brothers (London) Ltd, Ferranti Ltd, Leo Computers Ltd, EMI, English Electric Ltd and BTM/ICT/ICL. Other manufacturers' computers would be researched some years later.

He was seeking people who would be willing to act as co-ordinators of other people who needed to be found, and who could be persuaded to provide historical information about computers which they knew about or had worked on. The series of Elliott computers

which I could help with was the 400 series, which comprised the 401, 402, 403, 404 and 405; I had worked only on the 405, and knew one person who had worked on the 402, but I knew no one who had worked on the 401 and 403. I knew the man, R. G. Mills, who had specified the 404, and I discovered the specification he had written, but the machine was never built, so there was no work to do in respect of that particular machine.

I was very happy to do the work for the 405, and luckily, being something of a hoarder, I had kept some historic material about the machine. Even so, some research would be necessary. The 402 required more research, but at least I had a starting point – the person whom I knew who had worked on the machine, and who knew a few others.

But the 403 computer presented a huge problem. Only one computer had been built, and I could find no one in the UK who knew anything about it. The computer was commissioned for use in Australia by the British Government, to help develop guided weapons at the secret Long Range Weapons Establishment, at Woomera, in South Australia.

This project was going to represent a huge amount of work, not only for me but for others too, whom I would have to locate and persuade to help me collect the information together; they and I would be paid nothing for our labours. But the project came at quite a good time for me, because my consultancy business had almost wound down, and my work was then mostly doing maintenance on some websites.

The new project should be satisfying, would provide me with a lot of detective work which I would enjoy, and I would as a result be able to leave my mark on the history of British computing in a section of the website which would be developed at www.ourcomputerheritage.org.

That website now exists, and it has been accepted for archiving by the British Library, who store a copy. That copy is available to the public, as well as the master copy, which is at present hosted on a computer at Birkbeck, University of London. At any one time, the copy at Birkbeck is likely to be more up to date than the one at the British Library, because it is still being worked on at the time of writing (2016).

For each computer, the work was required to be set out in five sections:

A list of purchasers of the computer from Elliotts

Systems architecture

Instructions sets and timings

Software and sample programs

A list of references

I had to find manufacturers' documents, photographs and manuals from many sources: individuals who had happened to keep a copy, technical libraries and museums, and book extracts. Some of these required me to get special permission from official sources

to publish copies. In particular I needed to reproduce Elliott literature, and I discovered that BAE Systems were the owners of Elliott Brothers (no longer a trading company), and therefore they owned the copyright. I decided that I needed a letter of authority to ask for documents from various organisations, but in particular from BAE Systems. The letter is below. I found it necessary to use it several times during the course of the project.

science museum

BCS THE BRITISH COMPUTER SOCIETY

THE MUSEUM OF SCIENCE & INDUSTRY IN MANCHESTER

THE COMPUTER CONSERVATION SOCIETY

63 Collingwood Avenue
Tolworth
Surbiton
Surrey KT5 9PU

29th September 2003

To whom it may concern:

"Our Computer Heritage" is a project organised as a Working Party of the Computer Conservation Society, under the leadership of Professor Simon Lavington of the University of Essex. The objectives, scope and methodology of the project have been discussed with and approved by the British Library and the National Archive.

The Computer Conservation Society is itself a Specialist Group of the British Computer Society, with support from the Science Museum of London and the Museum of Science and Industry in Manchester.

This is to certify that Mr David Pentecost is an authorised co-ordinator, gathering specified information about certain computers listed in the definition of the pilot study stage of the project. You are requested to assist him in his investigations.

Hamish Carmichael

Hamish Carmichael
Hon. Secretary
The Computer Conservation Society

I wrote to the secretary at BAE Systems, and he gave me permission to make copies of Elliott documents. In some circumstances, I had to persuade people directly involved, to write text for me. One Elliott computer manual was recorded as being at Bletchley Park, but staff there failed to find it after a lengthy search in a hut full of documents, which had not yet been catalogued; many weeks later, someone came across the document and luckily remembered about my enquiry, so eventually I received a copy. Others I found in boxes in the Science Museum annexe at Blythe House, some I collected from an ex-Elliott employee who had kept them; photos came from many

sources, some from the Internet, some about the 405 computer from the Powerhouse Museum in Australia, where large parts of a 405 were on display.

Some documents needed to be included on the website, but were copies of copies and so poor that they could never be read without a struggle. I was obliged to re-type them in their original format using the same typeface, font size and with the same layout and page numbering. Then I had to double-check them for accuracy. Some of this work was very difficult, especially when it involved special symbols and small diagrams. I spent several weeks working seven hours a day just copy-typing and checking; scanning and using optical character recognition was possible in only a few cases. This part of the project was extremely tedious.

A large and exciting part of the detective work came when tracing people in Australia who had worked on the 403 computer. I was fortunate to find them; one led to another, and then to another and so on, and most were able to contribute in some respect; one of them had moved to Canada, and I managed to find him as well.

In November 2004, an email arrived addressed to someone at the British Computer Society office, and also to Simon Lavington; it came from John Deane, secretary of the Australian Computer Museum Society, who somehow knew of the Computer Conservation Society here in the UK, and he said "I've been chasing ELLIOTT 403 (WREDAC *[Weapons Research Establishment Digital Automatic Computer]*) material for some months & I'm about to order copies of circuit diagrams & some documentation from Aust Defence archives". He had found a document concerning magnetic tape storage equipment and wanted to know if it would be of any interest to us. Simon Lavington forwarded the message to me, which started a long series of exchanges of emails between me and several other people in Australia.

The timing was fortunate, because the Australian Government had recently de-classified all the 403 material. But it was not until March 2005 when John Deane was able to send me a list of almost fifty declassified 403 documents, and also his exchange of emails from mid 2004 with several people.

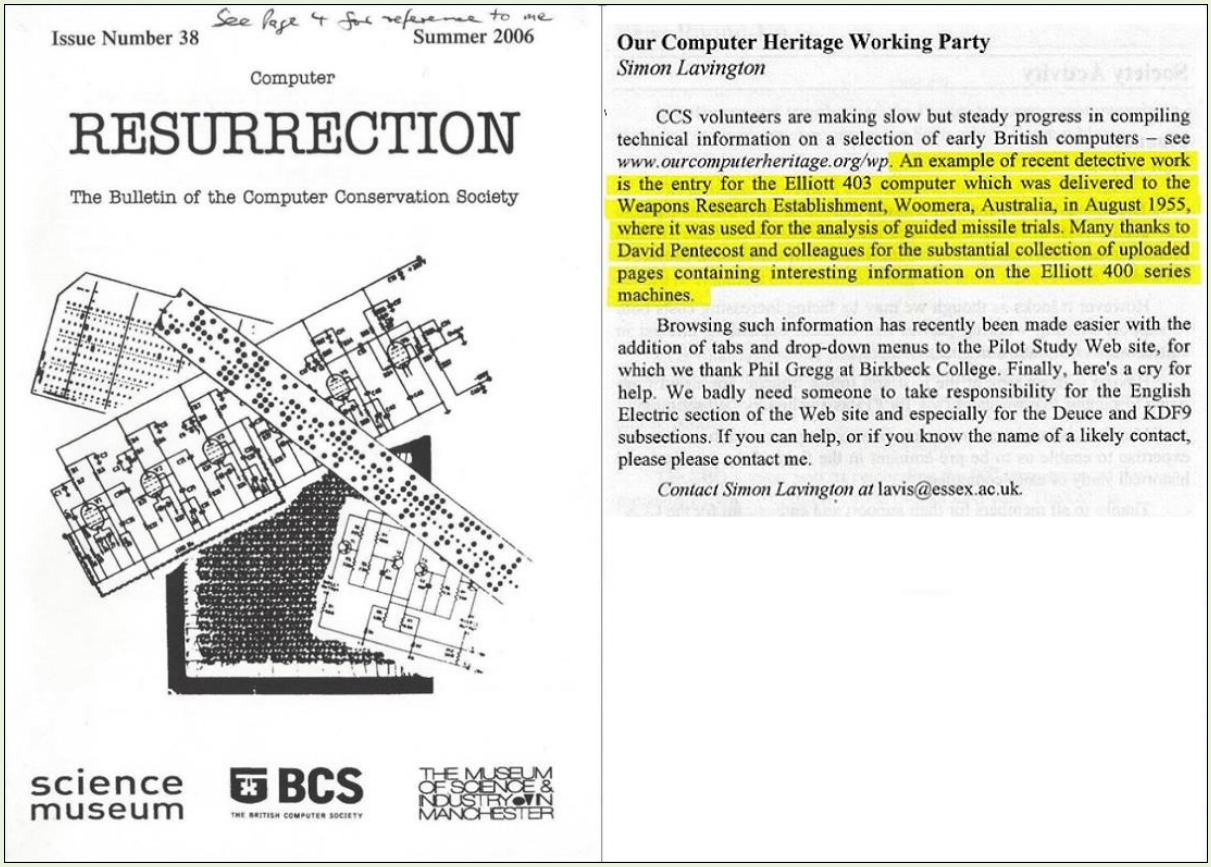
One of these was Barbara Biggins, who said that she had worked on WREDAC as an operator, and as a programmer from its installation until its eventual replacement by the IBM 7090, and she had some photos of the 403 and people working on it. The photos then came to me from John Deane.

Another set of emails was with Don Fenna, who had also worked on the 403, primarily for tracking guided missiles, and later with some software and hardware adaptations, also for tracking the Russian Sputnik satellite.

A third set of emails came from Jack Smith, in which I found addresses also for Alex Reid and Peter Main. And finally John Deane gave me the address of Peter Goddard, who had a photo of the Elliott nameplate of the 403; Peter was one of the chief programmers, and he knew of three more 403 people: John Weadon, John Penny and Frank Day. At last I had contacts with people who had direct knowledge and experience of the 403.

But there was nowhere near enough information about two key very senior figures, then both deceased: John Ovenstone and Don Overheu.

At the end of April 2005 I made myself known by a long explanatory email to Barbara Biggins, asking for her help to produce four of the sections of our website relating to the 403. She replied immediately, saying that she would do her best to help, and I responded by telling her how to set about the tasks, probably by first asking John Deane to send her copies of some of the documents which he had, which he subsequently did. She then said that she was handing over the project to Peter Goddard, who was better qualified than she was to undertake the required tasks. Peter was most helpful in producing the majority of the text, or pointing me in the right direction to obtain it from various books. Without his help, it would have been much more difficult, perhaps impossible, to complete the work on the 403 computer.



See Page 4 for reference to me

Issue Number 38 Summer 2006

Computer

RESURRECTION

The Bulletin of the Computer Conservation Society

science museum BCS THE BRITISH COMPUTER SOCIETY THE MUSEUM OF SCIENCE & INDUSTRY IN MANCHESTER

Our Computer Heritage Working Party

Simon Lavington

CCS volunteers are making slow but steady progress in compiling technical information on a selection of early British computers – see *www.ourcomputerheritage.org/wp*. An example of recent detective work is the entry for the Elliott 403 computer which was delivered to the Weapons Research Establishment, Woomera, Australia, in August 1955, where it was used for the analysis of guided missile trials. Many thanks to David Pentecost and colleagues for the substantial collection of uploaded pages containing interesting information on the Elliott 400 series machines.

Browsing such information has recently been made easier with the addition of tabs and drop-down menus to the Pilot Study Web site, for which we thank Phil Gregg at Birkbeck College. Finally, here's a cry for help. We badly need someone to take responsibility for the English Electric section of the Web site and especially for the Deuce and KDF9 subsections. If you can help, or if you know the name of a likely contact, please please contact me.

Contact Simon Lavington at lavis@essex.ac.uk.

From all the sources mentioned above, and a few others, I completed my work on the 403 computer, and in due course submitted it to Simon Lavington, who was in charge of the entire project. What I did not know, because none of my Australian contacts mentioned it, was that there was a second, ancillary, Elliott machine, which was in Australia named WREDOC. Simon Lavington found out about this from documentation which he discovered, and he amended and added to the texts which I had written. WREDOC was the 403's ancillary equipment used for bulk input/output of data. WREDOC's main mode of use was to accept from the 403, the analysis results, via magnetic tape, for off-line printing via a Bull lineprinter, and for graphical display.

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I owe a debt of gratitude to Peter Holland, for his help in producing material for the 401 computer. He had been working for some time on a project to get the 401, which is stored at the London Science Museum, to work once more.

And as far as the Elliott 402 computer is concerned, I had a good deal of information sent to me by Tony Limberg, who had worked on that computer many years previously. His help was invaluable.

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Anyone who wishes to read the results of my work on the massive project to create the sections of the website at www.ourcomputerheritage.org which relate to the Elliott 400 series of computers, must visit the website. I list below, addresses of links to some of my parts of the website. My texts for the site were submitted to the editor in 2011, and many of the texts are dated 2016 after editing. (As I understand it, the website is still being developed for later British computers, so it is not impossible that the links below may change from time to time; they were correct on 18.5.2023 for the 3rd edition of this book).

At https://www.ourcomputerheritage.org/Maincomp/Eli/ellio_15.htm you will find five boxes in the second column, about the Elliott 400 series of computers. The links to these five boxes are shown below. I was responsible for developing the first versions of these sections of the website.

1. https://www.ourcomputerheritage.org/Maincomp/Eli/ccs-e2x1.pdf A list of the Elliott 400 series computers delivered, and what applications were run on those computers.

2. https://www.ourcomputerheritage.org/Maincomp/Eli/ccs-e2x2.pdf

Systems architecture notes about the 400 series computers. Within this section is a link to a 186-page document which I produced on instruction sets and instruction times. It contains progamming manuals and some related papers for the Elliott 401, 402, 403 and 405 computers. Most of the document I very carefully typed and double-checked over a period of several weeks, from copies of original documents, because the copies were not in an acceptable condition to show as scanned documents. Some pages were barely legible.

Also within this section are 27 pages of notes about the 403 computer and its use at the Weapons Research Establishment (WRE), in Salisbury, Australia, compiled after much difficult research and over a long period of time, involving tracing people in Australia and elsewhere who worked on the 403.

A third link in this section, points to an 11-page document describing the use of a 405 computer which was donated to a school: the Forest Grammar School, in Winnersh, Berkshire. Within this document, there is, in turn, a link to a BBC film made about the school's 405.

3. https://www.ourcomputerheritage.org/Maincomp/Eli/ccs-e2x3.pdf

Instruction set timings. This section of the website defines the binary structure of the instructions used by the Elliott 400 series computers, and some details of the times taken for those instructions to be executed. It also contains links to the user manual documents which I prepared, for the 401, 402, 403 and 405 computers.

4. https://www.ourcomputerheritage.org/Maincomp/Eli/ccs-e2x4.pdf

Software and sample programs. This section shows examples of software for the 400 series computers; it is a much edited and reduced version of my original text, with the examples of software which I found, shown as separate documents, and now accessible by links within the text. One of the links gives full details on pages 16-25, about the 405 computer's automatic timing program which I wrote, which is also referred to in chapter 3 of this book.

5. https://www.ourcomputerheritage.org/Maincomp/Eli/ccs-e2x5.pdf

List of references

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That brings me to the end of the description of some of my contribution to the development of the website defining a history of the 400 series of Elliott computers. The work took place on and off during the period 2003 to 2011. It was stimulating research, and involved a good deal of detective activity which I found extremely enjoyable. Some of the work was very boring and taxing, especially the typing, some of which was tricky, with use of special characters, subscripts, superscripts, underlining, and even overlining. I am very satisfied with the results, and so glad that I had the opportunity to undertake the work. Simon Lavington, in charge of the entire project, was wise to initiate the project when he did, whilst some computer industry personnel who had worked in the 1950s and 1960s were still alive, and could be traced and persuaded to take part. I am proud of the legacy which I shall leave behind.

I have also now reached the end of the story of my paid working life, which was spent almost entirely, directly and indirectly, in the computer industry. My working life continued, as unpaid self-employment, in the world of music. The first edition of 'My Life in Music' was published in February 2017, printed as a limited edition, under ISBN reference 978-0-9518719-2-8; a copy was deposited as required by law, in the British Library. A second edition, updated to 2020 was published as an e-book, under reference ISBN 978-0-9518719-4-2, and was also deposited at The British Library. A third edition, updated in 2022, was published as an e-book under reference ISBN 978-0-9518719-6-6. A fourth edition is planned for publication as an e-book in the autumn of 2023.

Chapter 12: CHESS

I was first taught to play chess when aged about 9, by an uncle, John Hughes, who was a school teacher. I was fascinated by the game, and I was selected to play in the Christ's College, Finchley, school team, when aged about 12, having first joined the school's chess club. We played against other schools in the North London area. There were six players in a team, and I often played at board 5. But when occasionally I played at board two, more often than not, I won. I seemed for some reason to play better when I faced a stronger player.

This interest in the game continued, when there was an opportunity, during my employment. I reasoned that it would enhance my career opportunities if I played in a team representing my employer, where that was possible. The first opportunity was at Unit Trust Services, part of the Target Trust Group, where there was a sports and social club. I received a cup for being the runner-up in a competition in 1973.

On joining the law firm Coward Chance in London, I discovered that the firm had a chess team which played in Division B of the Central London Legal Chess League. We played against other law firms in the City of London, meeting at our offices or at our opponents' offices. In 1984, we won the league, and I received a commemorative cup.

Images of the two cups which I received are below.

After retirement in Cyprus, I thought that I might continue to play, and I found a gentleman in the old town of Limassol, who was keen to have a game. This must have been in 2004 or 2005. I was somewhat intimidated, for when entering his house, I saw that he had shelves full of books on chess.

We sat down in his courtyard to play without time clocks, which both of us preferred. After more than four hours, he resigned. I was mentally and a little physically exhausted after the encounter, in spite of having won.

Since then, I have not wanted to play the game. I have healthier, more creative and enjoyable ways of spending my time, with tennis, ten-pin bowling, music, and a little bridge from time to time.

Postscript, October 2020

A copy of Edition 2 of this book is stored on the website of the Computer Conservation Society (CCS), at:
www.computerconservationsociety.org/rd/pentecost.pdf

The Computer Conservation Society is a co-operative venture between the British Computer Society, the Science Museum in London, and the Science and Industry Museum in Manchester.

Here is an extract from page 11 of the Journal of the Computer Conservation Society, issue number 91, Autumn 2020:-

News Round-Up

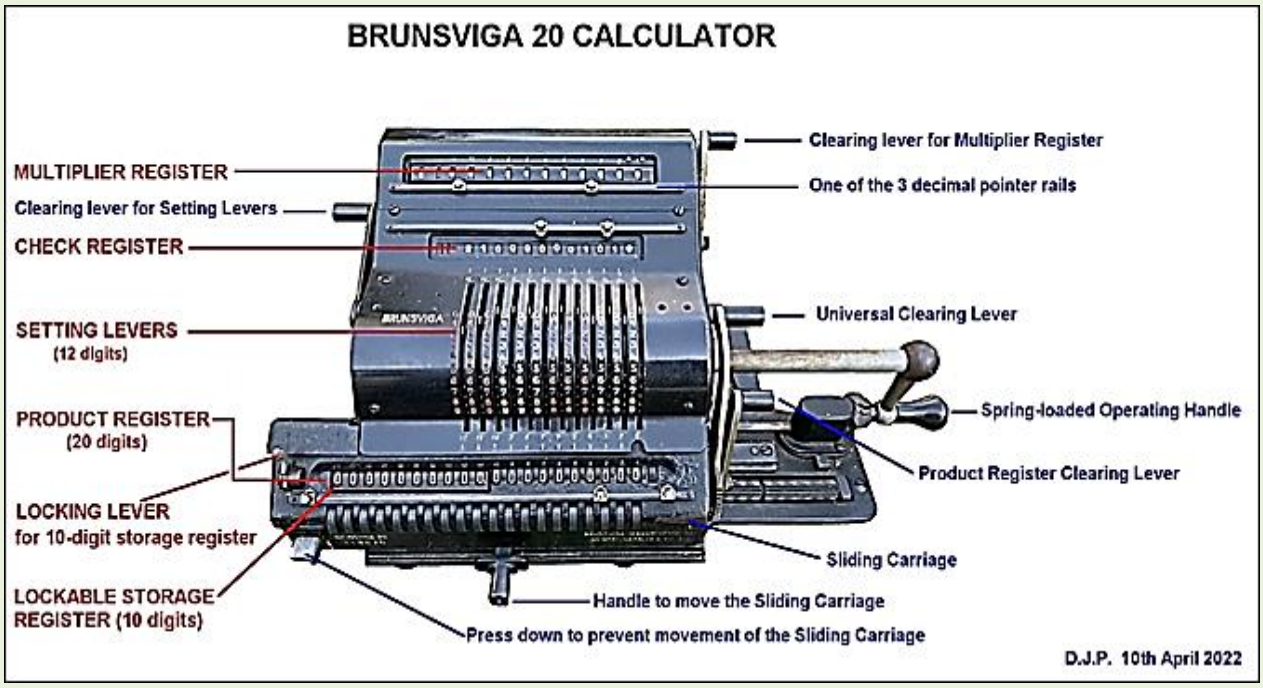
Regular readers will perhaps recall a series entitled *My Life in Computing*, in which CCS members recalled highlights from their interesting and varied computing careers. David Pentecost has gone one better and has written up the story of his career at length. The sheer variety of rôles which he has undertaken cannot fail to impress. From using DEUCE at the NPL in 1959 to specialising in IT services to the legal profession in the 1990s and latterly as a contributor to the CCS *Our Computer Heritage* project. Go to *www.computerconservationsociety.org/rd/pentecost.pdf* and enjoy!

Postscript, June 2023, regarding Edition 3

Having finally received my Fellowship of the British Computer Society (see notes in Chapter 3), I can now publish this 3rd edition of My Working Life, which I expect to be the final edition, as the second e-book edition, and I shall add a reference to it in the Wikipedia article about me. (The 1st edition of this book was privately produced as a hardback, and was not allocated an ISBN). The Wikipedia article can be found at: https://en.wikipedia.org/wiki/David_Pentecost.

There are some small text improvements throughout the book. In particular, the ourcomputerheritage.org website (see chapter 11), underwent some renaming of its pages since the second edition of this book was produced, which required me to change the links to sections of the website, to which I have referred in chapter 11.

Appendix, June 2023



(I was unable to find any original instruction manual for the Brunsviga 20 calculator, so I wrote these instructions for the benefit of my grandson Kai, to whom I gave the calculator).

OPERATING INSTRUCTIONS

Start by pulling down the Universal Clearing Lever as far as it will go, and then letting it return to its normal position. This will clear all the registers, setting each of them to zero.

Make sure that the Sliding Carriage is a far to the left as possible. Push the Handle to move the Sliding Carriage (middle bottom of the machine), to the left, as necessary, to do this.

Note that the Sliding Carriage can be moved step by step to right or left, by pushing its Handle in the direction required. If you want to move the Sliding Carriage many places to left or right, this can be achieved by first pushing in the Handle of the Sliding Carriage, and then, holding the Handle pushed in, move the Sliding Carriage to the position required.

1. Multiplying two numbers together

You are going to multiply 1739 by 2. To start the calculation, set up a number on the Setting Levers, so that the number you want is on the right hand side of the levers. So for the number 1739, move lever 4 down one notch, to show the number 1 in position 4 of the Check Register. Then move lever 3 down to position 7; you will see the digit 7 in position 3 of the Check Register. Follow this procedure for the last two digits, so that 3 appears in the Check Register in position 2, and 9 appears in position 1 of the Check Register. You

should now be able to read the number 1739 on the right side of the Check Register, as well as on the Setting Levers.

The next step is to make use of the Operating Handle on the right. Pull this Handle out to the right, to release it, and hold it out. While you hold it pulled out, the handle can now rotate clockwise or anti-clockwise. Rotate the handle clockwise twice, and then let it return on its spring to its resting position.

You will now see the number 2 in position 1 on the right side of the Multiplier Register at the top of the machine. And in the Product Register at the bottom of the machine, you will see the result (3478) of your calculation. You have multiplied 1739 by 2, giving the answer 3478.

This was a simple multiplication, performed by adding the number 1739 to itself twice. *Multiplication is, in effect, repeated addition. (Conversely, as you will see later, division is repeated subtraction, and is achieved by turning the Operating Handle anti-clockwise).*

You multiplied 1739 by 2. If you had wanted to multiply 1739 by 5 instead of by 2, you would have turned the Operating Handle clockwise 5 times.

Take another example: multiply 1739 by a larger number, such as 58. You could have done this by turning the Operating Handle clockwise 58 times. But this would take far too long. So deal with the multiplier 58 in two stages. First deal with the 8, and turn the Operating Handle 8 times clockwise. Now move the Sliding Carriage to the right one place, by pushing its handle (bottom centre of the machine) to the right, one notch. If you now look at the Multiplier Register at the top of the machine, you will see that the two small pieces of metal above the small engraved numbers have moved one place to the left, over the engraved number 2. Now you can pull out the Operating Handle again, and turn it clockwise 5 times. You will see the multiplier 58 at the top of the machine on the right, in the Multiplier Register. And the result of the multiplication, 1739 x 58 is shown as 100862 at the bottom of the machine in the Product Register. If you wish, you can slide the rightmost metal arrow pointer on its metal rail, on the Sliding Carriage, so that it is to the left of the 8 in the result, so that it looks more readable, like 100,862. The sliding metal arrows are thousands position indicators; they can also be used as decimal point position indicators.

What about decimal points? If you want to multiply 12.34 x 67.436, just treat the numbers as 1234 x 67436, and you will get the result 83216024. Add up the number of decimal places in the two original numbers, and this will tell you how many decimal places there will be in the result. So in this example, 12.34 has 2 decimal places and 67.436 has 3 decimal places. The total is 2+3=5, and therefore the result has 5 decimal places, so giving the answer 832.16024. You can, if you wish, use the sliding arrows on the rails of the Multiplier Register and on the Setting Levers, to remind you where the decimal points are.

2. Moving the number in the Product Register up to the Setting Levers

Suppose now that you need to multiply the number in the Product Register (100,862) by another number, say 431. The long way to do this would be to change the Setting Levers by hand, altering them from 1739 to 100862, and then multiply 100862 by 431. But there is a quick way to transfer a number from the Product Register automatically up to the Setting Levers. Do this as described below. (This will work only for 12 of the digits in the Product Register, because there are only 12 Setting Lever digits)

First, make sure that the Sliding Carriage is as far to the left as possible (assuming that you want to transfer up, 12 of the rightmost digits from the Product Register) .

With your left hand, pull down the Clearing Lever for Setting Levers, and hold it down. Then, with your right hand, pull down the Universal Clearing Lever as far as it will go, and finally let go of both levers. You will now see that the number 100862 is on the Setting Levers. The Product Register at the bottom, has now been set to zero, and so has the Multiplier Register at the top.

You can now multiply by 100862 by 431. With the Sliding Carriage as far left as possible, turn the Operating Handle clockwise once, so that 1 appears in the last position in the Multiplier Register. Push the Sliding Carriage one place to the right, and turn the Operating Handle clockwise three times. You will now see 31 in the Multiplier Register. Finally push the Sliding Carriage one more place to the right, and turn the Operating Handle clockwise four times. 431 is now showing in the Multiplier Register. And the product Register at the bottom shows the result of the calculation: 43471522. You can move two of the sliding metal arrows to make it clearer to read, as 43,471,522.

The above processes have enabled you to multiply three numbers together: 1739 x 58 x 431 = 43,471,522.

3. Adding numbers together

This needs little explanation, because you may have realised how to do this from the notes above on multiplication. First clear all the registers, using the Universal Clearing Lever. Set up the first number on the Setting Levers. Add in the number once, by turning the Operating Handle clockwise once; the number is now in the Product Register, where the total of all the numbers will be built up. Now set up the second number to be added to the total on the Setting Levers, and turn the Operating Handle clockwise once. The total of the two numbers is now in the Product Register. This process can be repeated for each other number to be included in the total.

4. Subtracting numbers

This is similar to the addition processing described in note 3. The difference, is that the Operating Handle is turned anti-clockwise, rather than clockwise, in order to subtract.

Take an example. To calculate 12,345 - 573 - 427. After clearing all the registers, first set up 12345 on the right hand side of the Setting Levers, and add it to the Product Register by turning the Operating Handle clockwise once. Now change the Setting Levers to 573, and subtract 573 from the total, by turning the Operating Handle anti-clockwise, once; the Product Register is now showing 11,772. Finally, change the Setting Levers to 427, and turn the Operating Handle once anti-clockwise; the Product Register now shows the result, which is 11,345.

5. Remembering the result of an interim calculation

Sometimes where you are doing a set of calculations, you may feel the need to write down a result, part way through your workings. Instead of writing the result down, you can make use of the Brunsviga's temporary storage. This is called the Lockable Storage Register, and it consists of the leftmost ten digits of the Product Register. These ten digits can be locked, and will not be affected by subsequent calculations which you do. Locking is achieved by pressing down the little Locking Lever near the bottom left of the machine.

But first, you need to move the number which you wish to remember into the Lockable Storage Register. Normally the number will initially be in the rightmost ten digit positions of the Product Register. First you must transfer the number to be remembered from the Product Register up to the Setting Levers, as described in Note 2 above. Make sure that the little Locking lever is in the Up position. Then move the Sliding Carriage as far to the right as possible. Turn the operating handle once clockwise, which will copy the number now on the Setting Levers down to the leftmost ten digit positions of the Product Register, i.e. into the Lockable Storage Register. Now push down the Locking Lever. Your interim calculation is now safely stored in the left half of the Product Register.

When the Locking Lever is down, the ten leftmost digits in the Product Register cannot be cleared by using the Product Register Clearing Lever, or the Universal Clearing Lever.

6. Manually setting up digits in the Product Register

This procedure is not normally necessary, but it is possible to set up digits in any position in the Product Register by hand. On the Sliding Carriage, beneath the decimal points rail, there is a rubber wheel under each of the 20 digit positions. Each wheel can be rotated by hand as many times as necessary, to set up a digit above the wheel in the Product Register. This works, even for the 10 leftmost digits, if the Locking Lever is in the down position.

7. Division

This is the method known as Tear Down Division, which is effectively repeated subtraction, just as multiplication is repeated addition.

First clear all the registers. Then move the carriage as far to the right right as you can. If you are dividing 38769 by 45, set up 38769 on the Setting Levers. You have to get 38769 into the Product Register before you can start the calculation, so first turn the Operating Handle clockwise once.
Clear the Setting Levers and the Multiplier Register. Now put 45 in the Setting Levers, but make sure that the most significant (leftmost) digit of the divisor is directly above the most significant digit of the number in the Product Register. So in this example, make sure that 4 is directly above the 3 which is showing in the product Register. Similarly, 5 on the Setting Levers must be directly above the 8 which is in the Product Register.

Start subtracting (turning the Handle anti-clockwise), and keep going until the number in the Product Register turns negative. In this particular example, it will turn negative immediately, because you are subtracting 45 from 38. This may be indicated by a bell ringing, but its main indicator is that the number in the Product Register starts with a string of nines, indicating a negative number. This means that you need to turn the Handle clockwise once, so that the Product Register turns positive again.

Shift the Carriage one place to the left. Now start subtracting again, until the Product Register once more turns negative (or until the bell rings). Turn the Handle clockwise once, to regain positivity of the Product Register.

Keep repeating this process. The answer will be shown in red on the left side of the Multiplier Register at the top of the machine. It gradually builds up, and shows you that the result is 861.53 recurring.

You will notice that for each step in the above process, you are turning the handle too many times: once anticlockwise and then once clockwise. This does not matter, but you can save time, if you watch the Product Register reducing as you are subtracting; you should be able to tell when to stop subtracting, just before the Product Register turns negative.

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